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MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

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FEBRUARY, 1930

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MEASUREMENTS OF SOLAR RADIATION INTENSITY AND DETERMINATIONS OF ITS DEPLETION BY THE ATMOSPHERE

By HERBERT H. KIMBALL

[Weather Bureau, Washington, D. C., February 25, 1930]

This paper is intended as a supplement to one on the same subjects that was published in this REVIEW, 55: 155–169, April, 1927. It is based principally on replies to a circular letter dated December 1, 1927, addressed to 30 heads of observatories or meteorological services, and requesting corrections and additions to the lists of pyrheliometric stations and the pyrheliometric data published in the earlier paper.

The replies received have resulted in the addition of 11 stations to the list of those measuring and publishing the total radiation (direct + diffuse) received on a horizontal surface, and of 4 stations that include in this measurement direct solar radiation only.

Forty stations have been added to the list of those measuring and publishing the intensity of direct solar radiation at normal incidence, but of these eight are stations in Union of Socialist Soviet Republics whose publications are not available to me.

A considerable number of stations previously listed have published additional data or summaries. These include all with station numbers less than 18 in Tables 1 and 2, and less than 100 in Tables 6, 7, and 8.

CORRECTIONS AND ADDITIONS TO PREVIOUSLY PUBLISHED DATA

The following corrections should be made in the data published in the REVIEW above cited:

Table 1: Toronto, period, blank; should be August, 1911–September, 1916.

Table 6:
- Batavia, altitude should be 15 meters.
- Innsbruck, longitude should be 11° 24′ E.
- La Quiaca, latitude should be 20° 06′ S; longitude should be 65° 36′ W; altitude should be 3,462 meters.
- Mount Czarnohora, Worchta should be Worochta.
- Pangerango, latitude should be 6° 45′ S; longitude should be 106° 58′ E.
- Paris, latitude should be 48° 48′ N.
- Sonnblick, longitude should be 12° 57′ E.
- Ursanova should be Ursynov.
- Zakopane, Austria, should be Poland.

Table 8:
- Jungfraujoch, Stein, M. Edward, should be Stenz, Edward.
- Paris, Bureau Central Meteorologique de France, 1907–1914, should be 1907–1924.
- Mémoires, 1907–1914, should be 1907–1924.

TABLE 1.—*Stations which obtain records of the total radiation received on a horizontal surface from the sun and sky*

Station	Latitude	Longitude	Altitude	Period	Instruments
	° ′	° ′	*Meters*		
(1) Lincoln, Nebr.	40 50 N	96 41 W	381	July, 1915–December, 1929.	Callendar.
(2) Madison, Wis.	43 05 N	89 23 W	308	April, 1911–December, 1929.	Do.
(3) Chicago, Ill.	41 47 N	87 35 W	210	September, 1923–December, 1929.	Weather Bureau thermoelectric.
(5) Washington, D. C.	38 56 N	77 05 W	137	November, 1914–October, 1922.	Callendar.
			126	November, 1922–December, 1929.	Weather Bureau thermoelectric.
(6) New York, N. Y. (Central Park Observatory.)	40 46 N	73 58 W	48	April, 1924–December, 1929.	Do.
(11) Davos Platz, Switzerland.	46 48 N	9 49 E	1,600	January, 1922–December, 1927.	Davos pyrheliograph.
(14) Stockholm, Sweden.	59 21 N	18 04 E	44	July, 1922–June, 1927.	Ångström.[1]
(15) Sloutzk (Pavlovsk, Union of Socialist Soviet Republics.	59 41 N	30 29 E	40	January, 1926–December, 1928.	Crova-Sloutzk;[1] Savinoff.
(18) La Jolla, Calif.	32 50 N	117 15 W	26	July, 1928 and November, 1928–December, 1929.	Weather Bureau thermoelectric.
(19 Pasadena, Calif.	34 15 N	118 17 W	246	1926–1928	Do.
(20) Fresno, Calif.	36 43 N	119 49 W	26	October, 1928–December, 1929.	Moll-Engelhard.
(21) Twin Falls, Idaho.	42 29 N	114 25 W	1,300	January, 1927–December, 1929.	Weather Bureau thermoelectric.
(22) Gainesville, Fla.	29 39 N	82 21 W	71	October, 1929–January, 1930.	Moll-Richard.
(23) Pittsburgh, Pa.	40 26 N	80 00 W	341	Dec. 24, 1929–Jan. 28, 1930.	Weather Bureau thermoelectric.
(24) Muottas-Muraigl.	46 32 N	9 53 E	2,456	July 21–Aug. 2, Oct. 2–14, 1923; Jan. 20–27, Mar. 8–13, 1924.	Ångström pyranometer.
(25) Zugspitze, Germany.	47 25 N	10 59 E	2,962	August, 1926–July 1927.	Do.
(26) Theodosia, Union of Socialist Soviet Republics.	45 02 N	35 24 E	15	March, 1926–December, 1928.	Crova-Sloutzk,[1] Savinoff.
(27) Kislovodsk, Union of Socialist Soviet Republics.	43 54 N	42 42 E	850	July–December, 1928.	Do.[1]
(28) Mount Elbrus, Union of Socialist Soviet Republics.	43 17 N	40 12 E	3,200	Aug. 10–19, 1926	Do.[1]

[1] Radiation records as recorded have been reduced to the Smithsonian pyrheliometric scale of 1913 by multiplying by 1.035.

TABLE 1.—*Stations which obtain records of the total radiation received on a horizontal surface from the sun and sky*—Continued

Station	Latitude	Longitude	Altitude	Period	Instruments
	° ′	° ′	*Meters*		
(29) Paris, France (Parc St. Maur).	48 48 N	2 29 E	50	1926	Moll thermopile; Richard register. (For cloudless skies.)
(30) Tiflis, Union of Socialist Soviet Republics.	41 43 N	44 48 E	421	June–August, 1927.	Å. Mi.,[1] Crova-Sloutzk.
(31) Tashkent, Union of Socialist Soviet Republics.	41 20 N	69 18 E	475	1926–1928	Å. Crova.[1]
(32) Irkutsk, Union of Socialist Soviet Republics.	52 16 N	104 19 E	467	1928	Å.[1] Crova-Sloutzk-Linke.

[1] Radiation records as recorded have been reduced to the Smithsonian pyrheliometric scale of 1913 by multiplying by 1.035.

TABLE 2.—*Sources of data given in Tables 3, 4, and 5*

(1) LINCOLN.
KIMBALL, HERBERT, H. 1916–1929. Solar and Sky Radiation Measurements. Mo. Wea. Rev., **44**: 178. Monthly thereafter.

(2) MADISON.
KIMBALL, HERBERT H., and MILLER, ERIC R. 1916. The Total Radiation Received on a Horizontal Surface from the Sun and Sky at Madison, Wis. Mo. Wea. Rev., **44**: 180.
KIMBALL, HERBERT H. 1916–1929. Solar and Sky Radiation Measurements. Mo. Wea. Rev., **44**: 179. Monthly thereafter.

(3) CHICAGO.
KIMBALL, HERBERT H. 1923–1929. Solar and Sky Radiation Measurements. Mo. Wea. Rev., **51**: 533. Monthly thereafter.

(5) WASHINGTON.
KIMBALL, HERBERT, H. 1915–1929. The Total Radiation Received on a Horizontal Surface at Washington, D. C. Mo. Wea. Rev. **43**: 100–111. Monthly thereafter.

(6) NEW YORK.
KIMBALL, HERBERT H. 1924–1929. Solar and Sky Radiation Measurements. Mo. Wea. Rev., **52**: 225. Monthly thereafter.

(11) DAVOS.
DORNO, C. 1928. Tägliche und Säkulare Schwenkungen du Sonnenstrahlung im Davos.

(14) STOCKHOLM.
ÅNGSTRÖM, ANDERS. 1928. Recording Solar Radiation. Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 4, No. 3.

(15) SLOUTZK.
KALITIN, N. N. Bulletin de la Commission Actinométrique permanente de l'Observatoiré Géophysique Central, 1925–1928.
Rates of solar energy according to observations effected at the Magnetic-Meteorological Observatory Sloutzk (Pavlovsk). Recuéil de Géophysik. Tome VI, Fascule 1.

(18) LA JOLLA.
RICHARDSON, BURT. 1929. See Solar Observations. Mo. Wea. Rev., **57**: 300. Monthly thereafter.

(19) PASADENA.
RICHARDSON, BURT. 1929. See Solar Observations. Mo. Wea. Rev., **57**: 300.

(20) FRESNO.
KIMBALL, H. H. Solar Observations. Mo. Wea. Rev. **57**: 26. Monthly thereafter.

(21) TWIN FALLS.
KIMBALL, H. H. 1927. Solar Observations. Mo. Wea. Rev. **55**: 29. Monthly thereafter.

(22) GAINESVILLE.
KIMBALL, H. H. 1930. Solar Observations. Mo. Wea. Rev. **58**: 26.

TABLE 2.—*Sources of data given in Tables 3, 4, and 5*—Continued.

(23) PITTSBURGH.
KIMBALL, H. H. 1930. Solar Observations. Mo. Wea. Rev. **58**: 26.

(24) MUOTTAS-MURAIGL.
DORNO, C. 1927. Grundzüge des Klimas von Muottas-Muraigl. (Oberengadin.)

(25) ZUGSPITZE.
LIPP, HERMANN. 1928. Beiträge zum Strahlungsklima der Zugspitze. Deutschen Meteorologischen Jahrbuch für Bayern.

(26) THEODOSIA.
KALITIN, N. N. 1927–1929. Bulletin de la Commission Actinométrique permanente de la Observatoiré Géophysique Central, 1926–1928.

(27) KISLOVODSK.
KALITIN, N. N. 1929. Bulletin de la Commission Actinométrique permanente de la Observatoiré Géophysique Central, 1928, 2–3.

(28) MOUNT ELBRUS.
KALITIN, N. N. 1928. Solar, Diffused and Terrestrial Radiation According to Observations Effected on Mount Elbrus. Jr. Geophysics and Meteorology. 3. N°. 3. 195–209. (Reprint.)

(29) PARIS.
BRAZIER, C. E. 1926. Observations et Travaux Actinométriques effectuis à l'Observatoire du Parc Saint-Maur pendant l'anne 1926. Annales, Institut de Physique du Globe de l'Université de Paris, VI., 121.

(30) TIFLIS.
Mossidse, Schalva. Aktinometrische Beobachungen am Geophysikalischen Observatorium Georgiens zu Tiflis. Aktinometrischer Monatsbericht, 1928, No. 1. (Georgien and Russian text with German abstract.)

(31) TASHKENT.
KALITIN, N. N. 1926–1928. Bulletin de la Commission Actinométrique permanente de l'Observatoire Géophysique Central.

(32) IRKUTSK.
KALITIN, N. N. 1928. Bulletin de la Commission Actinométrique permanente de l'Observatoiré Géophysique Central.

NEW DATA

Vertical component of solar radiation.—Table 3 gives monthly averages of daily totals of solar radiation received on a horizontal surface, (1) including both that received directly from the sun and that received diffusely from the sky; (2) the component received directly from the sun; and (3) the component received diffusely from the sky. These daily totals are obtained by means of instruments that make a continuous record of the intensity of the solar radiation that falls upon their receiving surfaces. In most cases the instrument records (1), the intensity of the total radiation (direct + diffuse). An increasing number of stations are now recording continuously the intensity of direct solar radiation at normal incidence. The vertical component of this intensity gives (2), above, and the difference between (1) and (2) gives (3), the intensity of the diffuse solar radiation received on a horizontal surface.

This latter measurement may be made by an instrument that will give the total (direct + diffuse) radiation, by interposing a screen between its receiving surface and the sun. It includes radiation received from both clear and cloudy skies.

Table 4 gives smoothed weekly averages of the total solar radiation (direct + diffuse) received on a horizontal surface. The averages have been smoothed by the well-known smoothing formula,

$$\frac{a+2b+c}{4}.$$

TABLE 3.—*Monthly averages of daily totals of solar radiation received on a horizontal surface (gram-calories per square centimeter)*

	January	February	March	April	May	June	July	August	September	October	November	December
Pasadena [1]	302	383	427	532	568	512	582	568	490	400	365	316
Pittsburgh [1]	95											
Davos [1]	186	286	358	381	470	454	487	524	585	346	232	176
Muottas-Muraigl [1]	[2] 284		[3] 500				[4] 805			[5] 456		
Zugspitze [1]	130	234	325	424	473	562	433	509	368	277	160	106
Stockholm: [1]												
1922–1927	25	73	181	295	344	416	422	310	209	110	47	22
1905–1926 [6]	29	75	186	295	422	450	414	319	218	107	49	22
Direct solar [7]	11	39	105	219	318	347	328	232	147	50	12	3
Diffuse solar [8]	18	36	81	76	104	103	86	87	71	57	37	19
Sloutzk [1]	25	70	194	269	341	389	445	296	176	69	19	11
Direct [7]	9	25	113	130	194	226	311	184	104	30	4	3
Diffuse [8]	16	45	81	129	147	163	134	112	72	39	15	8
Theodosia [1]	76	108	195	282	433	534	549	442	338	215	113	56
Direct [7]	-----	-----	117	-----	312	451	408	-----	284	143	34	9
Diffuse [8]	-----	-----	78	-----	121	83	141	-----	54	72	79	47
Kislovodsk [1]	-----	-----	310	357	377	393	483	-----	264	240	193	65
Direct [7]	-----	-----	169	181	236	255	372	-----	-----	-----	132	37
Diffuse [8]	-----	-----	141	176	141	138	111	-----	-----	-----	61	28
Mount Elbrus: [1]												
Clear sky	-----	-----	-----	-----	-----	-----	-----	697	-----	-----	-----	-----
Cloudy sky	-----	-----	-----	-----	-----	-----	-----	304	-----	-----	-----	-----
Paris: [7]												
Clear sky	110	180	305	475	560	580	570	500	390	275	135	95
Average sky	24	56	104	190	269	273	279	260	172	77	32	18
Tiflis [7]	-----	-----	-----	-----	-----	430	372	379	-----	-----	-----	-----
Tashkent [7]	65	119	186	293	332	541	522	511	387	225	124	58
Irkutsk [7]	28	97	204	260	285	334	345	272	172	118	35	28

[1] Total radiation (direct + diffuse).
[2] For Jan. 20–27.
[3] For Mar. 8–13.
[4] For July 23–Aug. 2.
[5] For Oct. 2–14.
[6] Computed.
[7] Vertical component of direct.
[8] Vertical component of diffuse.

TABLE 4.—*Weekly means of daily total solar radiation (direct + diffuse) received on a horizontal surface (gram-calories per square centimeter)*

Week	Washington	Madison	Lincoln	Chicago	New York	Twin Falls	Fresno	Gainesville	La Jolla
Jan. 4	151	138	185	79	107	176	123	310	272
Jan. 11	156	148	192	80	106	183	134	256	264
Jan. 18	164	164	202	88	115	191	190	222	248
Jan. 25	181	182	215	100	140	180	235	-----	257
Feb. 1	196	196	233	106	141	188	257	-----	260
Feb. 8	207	210	257	110	139	238	308	-----	268
Feb. 15	227	230	284	127	138	267	363	-----	310
Feb. 22	256	255	310	160	174	257	398	-----	361
Mar. 1	288	280	338	189	234	249	397	-----	376
Mar. 8	313	299	356	196	267	258	368	-----	344
Mar. 15	332	316	377	208	262	286	391	-----	322
Mar. 22	348	335	397	222	256	268	470	-----	378
Mar. 29	362	358	407	238	270	258	510	-----	417
Apr. 5	382	380	413	276	309	349	512	-----	446
Apr. 12	400	397	421	304	332	422	554	-----	456
Apr. 19	413	410	442	306	334	455	595	-----	424
Apr. 26	426	428	469	319	346	529	639	-----	473
May 3	444	450	480	355	355	604	691	-----	508
May 10	457	465	487	377	362	639	677	-----	488
May 17	466	474	515	384	375	710	656	-----	-----
May 24	482	482	528	402	396	734	696	-----	-----
May 31	492	493	522	420	411	693	706	-----	-----
June 7	493	505	528	421	412	657	667	-----	-----
June 14	490	509	536	412	408	664	684	-----	489
June 21	490	520	560	414	399	712	731	-----	509
June 28	499	533	586	436	402	710	734	-----	517
July 5	499	534	583	449	410	709	727	-----	530
July 12	485	526	572	432	405	726	728	-----	546
July 19	478	512	562	415	402	715	710	-----	515
July 26	470	490	543	396	397	681	690	-----	429
Aug. 2	452	469	521	366	370	648	678	-----	427
Aug. 9	437	454	504	356	346	638	647	-----	442
Aug. 16	428	443	495	362	331	617	609	-----	454
Aug. 23	421	430	485	368	314	591	602	-----	453
Aug. 30	405	404	462	357	317	569	601	-----	400
Sept. 6	385	370	428	315	289	544	575	-----	389
Sept. 13	366	347	405	284	308	520	516	-----	232
Sept. 20	354	335	373	267	274	496	467	-----	288
Sept. 27	338	298	349	234	244	464	459	-----	368
Oct. 4	321	270	323	208	247	429	444	-----	364
Oct. 11	300	247	307	190	247	407	414	428	294
Oct. 18	276	224	294	171	198	390	379	448	252
Oct. 25	259	204	269	154	188	351	335	423	248
Nov. 1	240	184	241	136	171	292	305	354	237
Nov. 8	219	162	221	114	144	232	290	344	240
Nov. 15	197	143	206	99	124	184	269	338	255
Nov. 22	177	131	198	92	116	152	241	274	272
Nov. 29	160	126	187	80	108	143	208	272	291
Dec. 6	147	121	172	72	101	136	174	307	290
Dec. 13	141	118	165	68	96	122	159	275	287
Dec. 20	141	122	170	72	99	130	150	263	280
Dec. 27 [1]	144	129	179	79	104	159	137	317	262

[1] 8-day period.

Table 5 gives the annual totals of solar radiation (direct + diffuse) received on a horizontal surface. They are expressed in both gram-calories per square centimeter and in kilowatt-hours per square dekameter. The latter values are included for the reason that the general public is more familiar with electrical than with heat units. They are obtained from the former by multiplying by the factor 1.161.

TABLE 5.—*Annual totals of solar radiation received on a horizontal surface (direct + diffuse)*

Stations	Gr. cal./cm.²	Kilowatt-hours	Stations	Gr. cal./cm.²	Kilowatt-hours
Pasadena, Calif.	165416	192048	Theodosia, Union of Socialist Soviet Republics	102007	118430
Fresno, Calif.	169691	197011			
Twin Falls, Idaho	153613	178345			
Lincoln, Nebr.	136346	158298			
Madison, Wis.	118744	137862			
Chicago, Ill.	90260	104792	Direct solar radiation only		
Washington, D. C.	121641	141225			
New York, N. Y.	94801	110064	Paris, France:		
Stockholm, Sweden	[1] 77486	[1] 89838	Average day	53227	61797
	[2] 78851		Clear day	125593	145930
Davos Platz, Switzerland	130657	151693	Tashkent, Union of Socialist Soviet Republics	102105	118544
Zugspitze, Germany	122125	141786			
Sloutzk, Union of Socialist Soviet Republics	69497	80686	Irkutsk, Union of Socialist Soviet Republics	64208	74545

[1] Instrumental record, 1922–27.
[2] Computed from relation between recorded amount and degree of cloudiness.

Solar radiation intensity at normal incidence.—In Table 6, under "Instruments," the following abbreviations have been employed:

Å = Ångström electrical compensation pyrheliometer.
Ma. = Marvin electrical resistance pyrheliometer.
S. I. = Smithsonian silver-disk pyrheliometer.
M. G. = Moll pyrheliometer as modified by Gorczyński.
Mi. = Michelson bimetallic pyrheliometer.

Table 7 summarizes the measurements of solar radiation intensity at normal incidence. In the column headed "Data" the symbols have the following significance:

A_m = intensity after the solar rays have passed through air mass m, where unit air mass is the atmosphere passed through with the sun in the zenith; and in general

$$m = \frac{\text{atmospheric refraction in seconds}}{58.36'' \times \sin Z (Z = \text{sun's zenith distance})}$$

A_{max} = mean of daily maximum intensities.
a = atmospheric transmission.

Numerical subscripts designate the values of m for which values of A or a are given. Thus,
A_2 = radiation intensity when m = 2.

$a_{0-1} = \frac{A_1}{A_0}$, or the transmission when the sun is in the zenith.

a_{2-3} = atmospheric transmission indicated by $\frac{A_3}{A_2}$

Table 8 gives the sources of the data summarized in Table 7.

It will be noted that the values of A_2 in Table 7 are higher in winter than in summer. This is partly due to the fact that the earth's radius vector reaches its maximum value in early July and its minimum in early January, and partly to the fact that the atmosphere contains much less water vapor in winter than in summer.

TABLE 6.—*List of pyrheliometric stations*

Station	Latitude	Longitude	Altitude	Period	Instrument
	° ′	° ′	*Meters*		
(100) Antibes, France	43 34 N	7 7 E	35	July, 1914–March, 1916	Crova.
(101) Antrea, Finland	61 00 N	29 14 E	15	June–August, 1922–23	Å., Mi. (S. I. scale).
(102) Ariana, Tunis	36 49 N	7 57 E	10	July, 1924–June, 1927	Richard-Moll.
(103) Baku, Union of Socialist Soviet Republics	40 22 N	49 50 E	14	October, 1922	Michelson actinograph.
(104) Borovoy, Samara, Union Socialist Soviet Republics.	53 00 N	52 03 E	82	1906–1918	Viola-Saveliev, Mi.
(15) Davos, Switzerland	46 48 N	9 49 E	1,600	1907–1927 (new summary)	Å., Mi. (reduced to S. I. standard).
(17) Eskdalemuir, Scotland	55 19 N	3 12 W	244	1922–1926 (continuation)	Å.[1]
(24) Fresno, Calif.	36 43 N	119 49 W	110	October, 1928	S. I.
(105) Giewont, Poland	49 15 N	20 00 E	1,900	Aug. 31, 1926	M. G.
(106) Golodnaya Steppe, Union Socialist Soviet Republics.	40 25 N	68 45 E	320	1914–15	Mi.
(107) Helsingiors, Finland	60 10 N	24 57 E	40	June, 1922–December, 1923	Å, Mi. (S. I. scale).
(108) Irkutsk, Union Socialist Soviet Republics	52 16 N	104 19 E	470	(*a*) 1913–1927; (*b*) 1928	Å.,[1] Crova, Mi.
(109) Jokkmokk, Sweden	66 36 N	19 51 E	255	June 29, 1927	M. G., Å.[1]
(110) Jungfruskar, Finland	60 9 N	21 5 E	20	July, 1922	Å., Mi. (S. I. scale).
(34) Katharinenburg (Sverdlovsk), Union of Socialist Republics.	56 50 N	60 38 E	280	1915–16	Mi., Å.,[1] Crova actinograph.
(35) Kew Obs'y. Eng.	51 28 N	0 18 W	6	1922–1926 (continuation)	Å.[1]
(111) Khanga, Algeria	34 49 N	6 43 E	253	June 17, 1877	Violle.
(36) Kief, Union of Socialist Soviet Republics	50 27 N	30 30 E	183	1888–1893, 1920–1928	Violle, Crova actinograph, Chwolson. Mi.
(112) Kislovodsk, Union of Socialist Soviet Republics.	43 54 N	42 42 E	850	May–December, 1928	Å., [1] Crova.
(113) Koursk, Union of Socialist Soviet Republics.	51 45 N	36 12 E	250	May, 1925–December, 1928	Mi.
(114) Laghouat, Algeria	33 48 N	2 55 E	750	July 12–13, 1877	Violle.
(42) Leningrad, Union of Socialist Soviet Republics.	59 56 N	30 16 E	5	1915–16, 1918, 1923–24, 1926–1928	Mi., Mi.-Marten, Chwolson.
(43) Lincoln, Nebr.	40 50 N	96 41 W	373	1926–1928 (continuation)	Ma.
(115) Lötschenlücke (Berne), Switzerland	46 28 N	7 57 E	3,240	August, 1926	Mi. (S. I scale).
(116) Lysina, Poland	49 46 N	20 4 E	912	April, 1923	Mi. (S. I. scale).
(45) Madison, Wis.	43 05 N	89 23 W	297	1926–1928 (continued)	Ma.
(49) Mont Blanc, France	45 49 N	6 52 E	4,810	Aug. 16, 1875	Violle.
			3,050	Aug. 17, 1875	
			1,200	Aug. 16–17, 1875	
(117) Montana (Wallis), Switzerland	46 19 N	7 28 E	1,515	August, 1926	Mi. (S. I. scale).
(52) Montpellier, France	43 37 N	3 53 E	44	1875–1877	Crova.
				December, 1911–July, 1914	Ångström
(53) Moscow, Union of Socialist Soviet Republics.	55 50 N	37 33 E	165	(*a*) 1909 to date; (*b*) 1914–1924	Mi., Å., Crova, S. I.
(118) Mount Elbrus (Krugozor), Union of Socialist Soviet Republics.	43 17 N	40 12 E	3,200	Aug. 8–20, 1926	Å.,[1] Savinoff.
(119) Mount Evans, Greenland	66 51 N	50 50 W	394	September, 1927–April, 1928	Moll. (S. I. scale).
			76–550	August, 1927	
(120) Muottas-Muraigl	46 32 N	9 53 E	2,456	July–August, 1923; October–January, 1923–24; March–June, 1924.	Mi., S. I.
(121) Oura-Tiube, Union of Socialist Soviet Republics.	39 55 N	69 00 E	1,040	January, 1907	Å.
(63) Paris, Parc St. Maur	48 48 N	2 29 E	50	1924–1926	Å., Mi., S. I.
(67) Potsdam, Germany	52 23 N	12 4 E	106	1907–1923	Å., Mi., S. I.
(122) Repetek, Union of Socialist Soviet Republics.	38 35 N	63 10 E	185	April, May, September, October, 1925	Mi.
(123) Rovaniemi, Finland	66 29 N	25 44 E	200	June, 1923	Å., Mi. (S. I. scale).
(124) Schbreiberhau (Reisengeberge), Germany	50 50 N	15 32 E	700	April, 1923; January, 1926	Mi.
(125) Sebastopol, Union of Socialist Soviet Republics.	44 36 N	33 32 E	12	1925	Mi., Crova.
(64) Sloutzk (Pavlovsk), Union of Socialist Soviet Republics.	59 41 N	30 29 E	30	January, 1926–December, 1928	Mi., Å.[1]
126) Smokovek, Czechoslovakia	49 8 N	20 13 E	1,015	1923–1926	Bimetallic, Å.[1]
(127) Stolzalpe, Austria	47 08 N	14 12 E	1,160	Aug. 10–17, 1925	Å.[1]
(128) Swinica, Poland	49 15 N	20 00 E	2,306	Sept. 1, 1926	M. G.
(75) Tashkent, Union of Socialist Soviet Republics.	41 20 N	60 18 E	480	1926–1928	Mi., A.[1]
(129) Tacubaya, Mexico	19 24 N	99 12 W	2,309	1911–1915	Å., S. I.
(130) Tagrait, Algeria	34 49 N	6 43 E	993	June 17, 1877	Violle.
(131) Tchimigan, Union of Socialist Soviet Republics.	70 km. NE Tashkent		1,400	June–July, 1923	Mi.
			1,980	July–August, 1925	
			3,200		
(81) Theodosia, Union of Socialist Soviet Republics.	45 02 N	35 24 E	15	February, 1926–December, 1928	Mi., Å.[1]
				June–August, 1927	Crova-Savinov actinograph.
(132) Tiflis, Union of Socialist Soviet Republics	41 43 N	44 48 E	420	September, 1913–December, 1915; June–August, 1927; January–December, 1928.	Å.,[1] Mi.
(133) Tomsk, Union of Socialist Soviet Republics.	56 30 N	84 58 E	124	March to May, October to November, 1901	Viol Saveliev.
(134) Touggourt, Algeria	33 09 N	6 02 E		March–April, 1924	Mi., S. I.
(135) Vienna, Austria	48 15 N	16 22 E	203	March, 1904–September, 1906	A.[1]
(136) Vladivostok, Union of Socialist Soviet Republics.	43 07 N	133 55 E	50	January–December, 1928	Å.[1] Crova, Viole-Saveliev.
(88) Warsaw, Poland	52 13 N	21 01 E	138	1919–1922	Mi., Å, S. I.
	52 13 N	21 03 E	86	1923–1928	M. G.
(89) Washington, D. C.	38 56 N	72 05 W	127	1914–1928	Ma.
(137) Yalta, Union of Socialist Soviet Republics	44 30 N	34 11 E	100	June–September, 1926; May–September, 1927	Mi.
(90) Zakopane, Poland	49 17 N	19 58 E	833	Aug. 28–Sept. 15, 1926	M. G.
(138) Zaleszczyki, Poland	48 39 N	25 44 E	190	Jan. 10–Sept. 21, 1924	M. G., Å. (S. I. scale).
(139) Zugspitze, Germany	47 25 N	10 59 E	2,962	Aug., 1926–July, 1927	S. I., Å., Mi.
(91) Atlantic Ocean	North Seas			Apr. 5–May 2; July 15–Aug. 15, 1923	Universal actinometer of Hartman & Braun, Frankfurt a Main.
Hamburg to Buenos Aires and return	Off Spanish coast; NE. trades; off Cape Verde Islands, calm zone, SE. trades.				

[1] Radiation records as recorded have been reduced to the Smithsonian pyrheliometric scale of 1913 by multiplying by 1.035.

TABLE 6.—*List of pyrheliometric stations*—Continued

Station	Latitude	Longitude	Altitude	Period	Instrument
	°	°			
Atlantic Ocean	39 N	10 W		Aug. 30, 1925	Ångström pyrheliometer standardized by comparison with Smithsonian silver-disk pyrheliometer.
NE. trades	26 N	16 W		Sept. 2, 1925	
Do	22 N	18 W		Sept. 3, 1925	
Calm zone	16 N	22 W		Sept. 4, 1925	
SE. trades	2 N	29 W		Sept. 7, 1925	
Do	3 S	32 W		Sept. 8, 1925	
Do	8 S	38 W		Sept. 9, 1925	
Do	13 S	38 W		Oct. 2, 1925	
Do	9 S	35 W		Oct. 3, 1925	
Do	5 S	33 W		Oct. 4, 1925	
Do	0	30 W		Oct. 5, 1925	
NE. trades	24 N	18 W		Oct. 10, 1925	
Do	29 N	16 W		Oct. 11, 1925	
	42 N	9 W		Oct. 14, 1925	
Atlantic Ocean	43.5 N	4.0 W		Apr. 22, 1928	Moll, S. I.
	43.5 N	9.0 W		Apr. 23, 1928	
	38.5 N	25.0 W		Apr. 25, 1928	
	37.0 N	31.0 W		Apr. 26, 1928	
	34.5 N	40.0 W		Apr. 27, 1928	
	33.0 N	47.0 W		Apr. 28, 1928	
	31.0 N	56.0 W		Apr. 29, 1928	
	27.5 N	70.0 W		May 1, 1928	
	26.0 N	77.0 W		May 2, 1928	

TABLE 7.—*Monthly means of solar radiation and atmospheric transmission*

Station	January	February	March	April	May	June	July	August	September	October	November	December
Tacubaya (129):												
A_m(max)	1.66	1.62	1.54	1.54	1.52	1.54	1.51	1.53	1.57	1.60	1.57	1.63
A_m	1.41	1.46	1.40	1.39	1.42	1.45	1.39	1.44	1.45	1.45	1.43	1.44
m	1.31	1.18	1.07	1.02	1.00	1.01	1.00	1.01	1.05	1.13	1.27	1.36
$a_{0\text{-}1}$					.75	.77	.74	.76				
Fresno (24):												
A_2										1.14		
$a_{2\text{-}3}$										.82		
$a_{0\text{-}1}$										.72		
Lincoln (43):												
A_2	1.40	1.37	1.25	1.20	1.12	1.10	1.07	1.07	1.17	1.20	1.36	1.38
$a_{2\text{-}3}$	.84	.86	.87	.82	.84	.84	.83	.83	.85	.91	.88	.87
$a_{0\text{-}1}$				.75	.73	.72	.71	.69	.73	.76		
Madison (45):												
A_2	1.36	1.37	1.30	1.22	1.11	1.10	1.03	1.10	1.16	1.19	1.31	1.32
$a_{2\text{-}3}$	.90	.88	.91	.89	.86	.87	.87	.86	.88	.88	.88	.93
$a_{0\text{-}1}$				.74	.72	.71	.68	.69	.71	.72		
Washington (89):												
A_2	1.23	1.18	1.14	1.09	.98	.91	.94	.96	1.05	1.10	1.18	1.23
$a_{2\text{-}3}$	.83	.82	.83	.83	.81	.82	.82	.84	.83	.86	.85	.84
$a_{0\text{-}1}$			.71	.71	.68	.65	.63	.64	.69	.72		
Paris (Parc St. Maur) (63):												
A_m(max)	1.08	1.32	1.37	1.43	1.35	1.39	1.39	1.37	1.38	1.27	1.19	1.18
m_{max}	3.15	1.90	1.61	1.31	1.19	1.30	1.24	1.24	1.59	1.98	2.94	3.08
A_m	.87	1.05	1.16	1.20	1.21	1.16	1.19	1.21	1.19	1.07	.96	.78
m	3.19	2.20	1.09	1.37	1.21	1.20	1.18	1.28	1.54	1.83	2.78	3.49
Antibes (100):												
$A_{m=2.35}$	1.32	1.32	1.20	1.08	.98	1.01	1.05	1.00	1.04	1.10	1.30	1.29
A_m	1.34	1.40	1.38	1.35	1.36	1.36	1.41	1.34	1.36	1.31	1.31	1.26
m	2.32	1.80	1.42	1.20	1.10	1.06	1.08	1.15	1.31	1.64	2.14	2.54
A_2	1.43	1.38	1.32	1.23	1.12	1.20	1.17	1.07	1.12	1.22	1.41	1.41
$a_{2\text{-}3}$	.82	.91	.83	.86	.83	.80	.86	.89	.83	.83	.89	.87
Montpellier (52):												
A_m	1.24	1.20	1.34	1.34	1.24	1.12	1.20		1.20	1.20	1.15	1.23
m	2.63	2.13	1.39	1.22	1.10	1.06	1.08		1.32	1.76	2.40	2.82
A_m	.99	1.29	1.30	1.31	1.30	1.29	1.26			1.17	1.15	1.02
m	2.32	1.80	1.42	1.20	1.10	1.07	1.08			1.64	2.18	2.54
A_2		1.27	1.00	1.24	1.06	1.09	.79			1.11	1.20	1.21
$a_{2\text{-}3}$		.84	.81	.83	.81	.85	.70			.79	.85	.88
$a_{0\text{-}1}$		.76	.70	.70	.70	.73	.68			.73	.74	
Mont Blanc Summit (49)—												
$A_{m=1.36}$								2.39				
Grands-Mulets—												
$A_{m=1.36}$								2.26				
Glacier der Bossont:												
$A_{m=1.36}$								2.02				
$a_{(4,810\text{-}1,300}$ meters)								.88				
$a_{(2,050\text{-}1,300}$ meters)								.92				
Khanga (111)—												
$A_{m=1.28}$							1.60					
Laghouat (114)—												
A_2							1.52					
$a_{2\text{-}3}$							.88					
$a_{0\text{-}1}$							.80					
Tagrait (130)—												
$A_{m=1.38}$						1.75						
A_2						1.55						
$a_{2\text{-}3}$						.87						
$a_{0\text{-}1}$						.83						
Touggourt (134)—												
A_2			1.19	1.18								
$a_{2\text{-}3}$			.87	.85								
$a_{0\text{-}1}$			.74	.72								

TABLE 7.—*Monthly means of solar radiation and atmospheric transmission*—Continued

Station	January	February	March	April	May	June	July	August	September	October	November	December
Ariana (102)—												
A_2	1.28	1.29	1.18	1.19	1.13	1.10	1.11	0.99	0.91	1.14	1.29	1.33
$a_{2\text{-}3}$	.83	.83	.80	.81	.84	.84	.83	.79	.79	.84	.86	.86
$a_{0\text{-}1}$	.78	.79	.78	.79	.75	.75	.75	.70	.66	.74	.78	.78
Vienna (135):												
A_2	.90			.94			.81			.87		
$a_{2\text{-}3}$	.86			.78			.82			.85		
$a_{0\text{-}1}$	.60			.59			.57					
Stolzalpe (127):												
A_2								1.24				
$a_{2\text{-}3}$								.87				
$a_{0\text{-}1}$								.79				
Davos (15):												
A_2	1.42	1.38	1.31	1.33	1.25	1.21	1.22	1.29	1.31	1.33	1.35	1.43
$a_{2\text{-}3}$	.85	.86	.82	.88	.92	.93	.93	.88	.89	.89	.87	.82
$a_{0\text{-}1}$	.84	.83	.81	.81	.79	.78	.75	.78	.79	.81	.82	
Muottas-Muraigl (120):												
A_2	1.57		1.47			1.27	1.34			1.47		
$a_{2\text{-}3}$	.92		.90			.90	.90			.92		
$a_{0\text{-}1}$			.84			.78	.82			.86		
Lötschenlücke (115):												
A_2								1.35				
$a_{2\text{-}3}$								.91				
$a_{0\text{-}1}$								.83				
Montana (117):												
A_2								1.28				
$a_{2\text{-}3}$								.88				
$a_{0\text{-}1}$								.80				
Zugspitze (139):												
A_2	1.56	1.59	1.55	1.49	1.42	1.41	1.42	1.44	1.47	1.53	1.63	1.51
$a_{2\text{-}3}$	.94	.94	.92	.91	.91	.92	.90	.90	.92	.92	.90	.95
$a_{0\text{-}1}$		.85	.86	.85	.84	.83	.85	.85	.85	.82		
Eskdalemuir (17):												
A_m	.89	1.02	1.15	1.17	1.26	1.20	1.25	1.20	1.19	1.14	.89	.85
m	4.14	2.70	1.83	1.43	1.24	1.18	1.20	1.33	1.63	2.29	3.55	4.98
Kew (35):												
A_m	.70	.94	.97	1.01	1.05	1.06	1.03	1.06	1.00	.95	.74	.90
m	3.28	2.31	1.69	1.33	1.18	1.13	1.15	1.26	1.50	2.02	2.90	3.77
Potsdam (67):												
A_2		1.18	1.08	1.13	1.07	1.06	.99	.98	1.13	1.19		
A_2	1.09	1.05	.94	.93	.90	.89	.80	.77	.93	1.01	.96	1.10
$a_{2\text{-}3}$		.89	.87	.82	.84	.84	.81	.79	.92	.85		
$a_{0\text{-}1}$			.63	.70	.70	.70	.65	.64	.71			
Schreiberhau (124):												
A_2		1.37	1.31	1.21	1.12	1.19	1.12	1.23	1.26	1.39	1.38	
A_2	1.37	1.25	1.13	.98	.85	.98	.92	1.13	1.18	1.24	1.28	1.30
$a_{2\text{-}3}$		.91	.87	.81	.76	.83	.82	.92	.93	.89	.92	
$a_{0\text{-}1}$			.80	.78	.78	.76	.76	.74	.79	.80	.76	
Smokovek (126):												
A_2	1.48	1.42	1.40	1.30	1.18	1.21	1.18	1.18	1.32	1.38	1.31	
A_4	1.21	1.17	1.03	.92	.83	.93	.92	.88	1.06	1.09	1.20	1.19
$a_{2\text{-}3}$	.90	.91	.86	.86	.82	.88	.88	.84	.91	.89	.97	
$a_{3\text{-}10}$			.83	.77	.75	.75	.74	.73	.73	.74		
Lysina (116):												
A_2				1.18								
$a_{2\text{-}3}$				.87								
$a_{0\text{-}1}$				.73								
Glewont (105):												
A_2								1.50				
$a_{2\text{-}3}$								.97				
$a_{0\text{-}1}$								.86				

TABLE 7.—*Monthly means of solar radiation and atmospheric transmission*—Continued

Station	January	February	March	April	May	June	July	August	September	October	November	December
Swinica (128):												
A_2									1.54			
$a_{2\text{-}3}$									.94			
$a_{e\text{-}1}$									.86			
Warsaw (88):												
A_{max}	0.98	1.14	1.21	1.24	1.22	1.22	1.22	1.21	1.14	1.11	1.02	0.91
m	3.47	2.50	1.87	1.46	1.34	1.33	1.24	1.40	1.69	2.18	3.07	4.45
$A_{abs\text{-}max}$	1.21	1.42	1.43	1.43	1.42	1.38	1.37	1.40	1.39	1.40	1.34	1.26
m	3.24	2.22	1.79	1.34	1.30	1.28	1.39	1.28	1.29	1.78	2.56	3.66
Zakopane (90):												
A_2	1.29			1.20					1.18			
$a_{2\text{-}3}$	.91			.84					.90			
$a_{e\text{-}1}$				.79					.78			
Zaleszczyki (138):												
A_2									1.25			
$a_{2\text{-}3}$									.88			
$a_{e\text{-}1}$									.75			
Helsingfors (107):												
A_2		1.19		1.24		1.16		1.24		1.26		
A_m [1]		1.01		.97		.93		.99		1.03		
A_m [1,4]												.86
$a_{2\text{-}3}$		.92		.87		.89		.89		.91		
$a_{e\text{-}1}$		.65		.74		.69		.76		.70		
Antrea (101):												
A_2						1.17	1.21	1.26				
A_4						.96	.91	.98				
$a_{2\text{-}3}$						.90	.86	.87				
$a_{e\text{-}1}$						.74	.77	.75				
Jungfruskär (110):												
A_2							1.24					
A_4							.94					
$a_{2\text{-}3}$							.87					
$a_{e\text{-}1}$							.75					
Rovaniemi (123):												
A_2						1.19						
A_4						.93						
$a_{2\text{-}3}$						.88						
$a_{e\text{-}1}$						.76						
Jokkmokk (109):												
A_2						.98						
$a_{2\text{-}3}$						.82						
Mount Evans (119):												
A_m		1.25	1.51	1.36					1.31	1.25		
m		5.0	2.5	2.5					2.5	3.5		
A_2		1.51	1.54	1.43				[1] 1.22	1.36	1.45		
$a_{2\text{-}3}$		.90	.92	.90				.88	.91	.91		
$a_{e\text{-}1}$			.87	.82				.73	.79			
Leningrad [2] (42).												
Sloutzk (64a):												
A_5	.94	.99	.87	.81	.78	.80	.74	.72	.83	.97	.99	
A_2			1.31	1.25	1.15	1.18	1.13	1.08	1.26	1.41		
$a_{2\text{-}3}$			.90	.87	.87	.86	.86	.86	.89	.84		
$a_{e\text{-}1}$			.75	.75	.69	.73	.70	.68	.81			
Sloutzk (64b):												
A_5	.95	.91	.85	.77	.73	.70	.66	.70	.74	.83	.93	.93
A_2		1.31	1.27	1.20	1.13	1.09	1.07	1.15	1.18	1.28		
$a_{2\text{-}3}$		.89	.86	.85	.85	.85	.83	.84	.85	.84		
$a_{e\text{-}1}$			.80	.79	.77	.76	.74	.76	.76			
Koursk (113):												
A_4	1.09	1.02	1.06	.83	.87	.80	.80	.87	.76	1.05	1.14	
A_2		1.35	1.35	1.16	1.14	1.12	1.03	1.07	1.16	1.31		
$a_{2\text{-}3}$		.86	.88	.84	.88	.85	.85	.85	.85	.87		
$a_{e\text{-}1}$			.79	.72	.69	.69	.66	.70	.75	.80		
Moscow (53):												
$A_{abs\ max}$	1.13	1.38	1.44	1.44	1.53	1.40	1.40	1.41	1.39	1.29	1.21	1.11
Kief [2] (36).												
Sevastopol [2] (125).												
Theodosia (81):												
A_2	1.03	1.12	.92	.86	.88	.88	.83	.88	.92	1.02	1.00	1.14
A_2	1.15	1.16	1.08	1.02	1.05	1.05	1.04	1.05	1.11	1.17	1.07	
$a_{2\text{-}3}$	.90		.86	.84	.83	.83	.79	.83	.83	.88	.94	
$a_{e\text{-}1}$			.64	.66	.71	.72	.72	.68	.70	.70		
Tiflis (132):												
A_m	1.26	1.29	1.34	1.32	1.42	1.36	1.32	1.34	1.30	1.27	1.27	1.19
m	2.10	1.74	1.44	1.18	1.09	1.05	1.07	1.13	1.27	1.51	1.97	2.33
$A_{2.37}$	1.20	1.17	1.14	1.03	1.11	1.05	.98	1.05	1.08	1.13	1.19	1.20
A_2	1.32	1.28	1.31	1.18	1.19	1.10	1.12	1.15	1.22	1.27	1.18	1.27
$a_{2\text{-}3}$	.85	.89	.87	.89	.83	.85	.83	.85	.86	.88	.89	.90
$a_{e\text{-}1}$	.80	.77	.76	.72	.75	.74	.74	.74	.78	.76	.68	
Mount Elbrus (118):												
A_2								1.38				
$a_{2\text{-}3}$								.89				
$a_{e\text{-}1}$								.87				
Kislovodsk (112):												
A_2					1.23	1.21	1.16	1.19	1.23	1.31	1.33	
$a_{2\text{-}3}$					.86	.86	.86	.86	.87	.89	.87	
$a_{e\text{-}1}$					.78	.76	.73	.76	.74	.73		
Baku [2] (103).												
Tomsk (133):												
A_m			1.29	1.32	1.29					1.16	.99	
m			1.74	1.46	1.28					2.77	4.28	
Yalta [2] (134).												
Borovoy [2] (104).												
Katherinenburg (34):												
A_m	.93										1.09	.79
m	4.0										4.0	6.0

[1] Within 30 miles east from Mount Evans.
[2] Not found in U. S. Weather Bureau library.

TABLE 7.—*Monthly means of solar radiation and atmospheric transmission*—Continued

Station	January	February	March	April	May	June	July	August	September	October	November	December
Katherinenburg (34)—Contd.												
A_2		1.34	1.28	1.21	1.16	1.13	1.04	1.20	1.20	1.31		
$a_{2\text{-}3}$		.87	.87	.88	.87	.83	.83	.85	.88	.90		
$a_{e\text{-}1}$				.78	.74	.73	.72	.74				
Golodnoya Steppe [2] (106).												
Oura Tiube [2] (121).												
Repetek [2] (122).												
Tashkent (75):												
A_2	1.22	1.27	1.15	1.05	1.02	.94	.92	.99	1.02	1.07	1.23	1.28
A_2	1.44	1.41	1.31	1.24	1.18	1.10	1.09	1.15	1.20	1.21	1.34	1.45
$a_{2\text{-}3}$	.85	.90	.85	.84	.87	.85	.84	.86	.86	.88	.92	.89
$a_{e\text{-}1}$		.80	.82	.81	.73	.72	.72	.71	.73	.71	.74	
Tchimigan [2] (131).												
Irkutsk (108b):												
A_4	.82	.96	.98	.90	.99	.91	.85	.86	.96	.86	.84	.91
A_2	1.34	1.39	1.24	1.21	1.28	1.14	1.08	1.16	1.23	1.12		
$a_{2\text{-}3}$	.77	.83	.89	.84	.86	.89	.89	.86	.89	.88		
$a_{e\text{-}1}$			.71	.75	.77	.67	.70	.72	.72			
Vladivostock (136):												
A_2	1.30	1.18	1.17	.96	.85	.90	.99	.94	1.07			
A_2	1.52	1.34	1.37	1.25	1.13	1.12	1.15	1.14	1.22			
$a_{2\text{-}3}$	.85	.88	.85	.81	.76	.82	.86	.83	.87			
$a_{e\text{-}1}$		.77	.83	.82	.77	.74	.73	.74	.75			
Atlantic Ocean (91):												
North Sea—				[3]								
A_2				1.09								
$a_{2\text{-}3}$				.81								
$a_{e\text{-}1}$				.71								
Off Spanish coast—												
A_2				1.07								
$a_{2\text{-}3}$				.82								
$a_{e\text{-}1}$				.69								
N. E. trades—												
A_2				1.16								
$a_{2\text{-}3}$				.84								
$a_{e\text{-}1}$				.74								
Off Cape Verd. I.—												
A_2				.76								
$a_{2\text{-}3}$				.70								
$a_{e\text{-}1}$				.60								
Calm Zone—												
A_2				.97								
$a_{2\text{-}3}$				.88								
$a_{e\text{-}1}$				.67								
S. E. trades—												
A_2				1.15								
$a_{2\text{-}3}$				.87								
$a_{e\text{-}1}$				.74								
Off Portugal—												
$A_{2.3}$								.89				
N. E. trades—												
A_2									.79			
$a_{2\text{-}3}$									.73			
$a_{e\text{-}1}$									.59			
N. E. trades—												
A_1									1.06			
$a_{e\text{-}1}$									.87			
Calm Zone—												
A_2									.75			
$a_{2\text{-}3}$									.71			
$a_{e\text{-}1}$									.58			
S. E. trades—												
A_1									1.25			
$a_{e\text{-}1}$									.66			
S. E. trades—												
A_1									1.24			
$a_{e\text{-}1}$									.65			
S. E. trades—												
A_1									1.28			
$a_{e\text{-}1}$									.67			
S. E. trades—												
A_1										1.36		
$a_{e\text{-}1}$										.70		
S. E. trades—												
$A_{1.3}$										1.26		
S. E. trades—												
A_1										1.34		
$a_{e\text{-}1}$										.69		
S. E. trades—												
A_2										1.11		
$a_{2\text{-}3}$										.86		
$a_{e\text{-}1}$										.68		
N. E. trades—												
A_2										1.18		
$a_{2\text{-}3}$										.89		
$a_{e\text{-}1}$										.75		
N. E. trades—												
A_2										1.19		
$a_{2\text{-}3}$										.87		
$a_{e\text{-}1}$										.72		
Coast of Spain—												
A_2										1.26		
$a_{2\text{-}3}$										.89		
$a_{e\text{-}1}$										.69		

[2] Not found in U. S. Weather Bureau library.
[3] See dates in Table 6.

TABLE 7.—*Monthly means of solar radiation and atmospheric transmission*—Continued

Station	January	February	March	April	May	June	July	August	September	October	November	December
North Atlantic Ocean:												
Bay of Biscay—												
$A_{1.17}$				1.33								
Off Spain—												
$A_{1.17}$				1.35								
Off Azores—												
$A_{1.16}$				1.37								
S. Temperate—												
$A_{1.09}$				1.33								
S. Temperate—												
$A_{1.08}$				1.32								
S. Temperate—												
$A_{1.06}$				1.29								
S. Temperate—												
$A_{1.04}$				1.24								
S. Temperate—												
$A_{1.03}$					1.22							
Off Bahama I.—												
$A_{1.02}$					1.19							

TABLE 8.—*Source of pyrheliometric data*

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TABLE 8.—*Source of pyrheliometric data*—Continued

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TABLE 8.—*Source of pyrheliometric data*—Continued

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TABLE 8.—*Source of pyrheliometric data*—Continued

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NOTE.—After this paper had been submitted for publication the following was received: "Tabellen der Intensität der Sonnenstrahlung in Mittel-Europa," Heft 1, Januar, 1930. Zusammengestellt vom Meteorologisch-Magnetischen Observatorium Potsdam. It summarizes pyrheliometric observations for January, 1930, for the following stations: Breslau-Krietern; Davos; Karlsruhe; Potsdam; Schömberg b. Wildbad i. Württemberg; Serfaus, Tirol (Ob. Inntal); Taunus-Feldberg; Wien; Wyk auf Föhr.

ATMOSPHERIC DEPLETION OF SOLAR RADIATION

Figure 1 is similar to Figure 3 in the paper of April, 1927, except that it has been extended to cover a greater range of atmospheric water vapor (depth of water, W, that would be obtained if all the water vapor in the atmosphere were precipitated). Full details of the construction and use of the table are given in the earlier paper.

In Table 9 are given values of a_{0-1} taken from Table 7, and a_{0-2} computed from $\frac{A_2R^2}{A_0}$ where R is the earth's radius vector in terms of its mean value, and $A_0 = 1.940$ gr. cal. per min. per sq. cm., the mean value of Abbot's determinations of the solar constant. There are also given values of a_{0-1} and a_{0-2} for dust-free air that have been obtained by interpolation between curves 9 to 13 of Figure 1.

In using these curves it is necessary to remember that unit air mass on the air-mass scale of this figure represents a *dry-air-pressure* of 760 mm. The dry-air pressure at a station is represented by $m = B - e$, where B is the station barometric pressure and e is the water-vapor pressure. Therefore unit air mass for the station, m', will fall at $\frac{B-e}{760}$ on the air mass scale of the figure.

For stations at or near sea level it is not necessary to consider this small deviation from standard air mass. In the computations for Table 9 unit air mass for Madison, Wis., falls at about 0.96 on the air-mass scale of Figure 1; for Lincoln, Nebr., at about 0.95, and for Davos, Switzerland, at 0.82. At any point on curves 9 to 15, inclusive, Figure 1, the water-vapor content of the atmosphere through which the sun's rays pass is represented by $m'W=\frac{B-e}{760}W$, where W has the value assigned to it for the respective curves.

TABLE 9.—*Depletion of solar radiation by atmospheric dust*

WASHINGTON, D. C.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
P (mm.)	754	753	752	751	750	750	750	751	753	753	753	754
W (mm.)	6.0	6.1	8.2	11.1	17.6	28.9	33.1	31.7	24.5	16.4	10.0	6.9
a_{0-1}:												
(Pyr.)	----	----	.71	.71	.68	.65	.63	.64	.69	.72	----	----
Dust-free air	----	----	.81	.80	.77	.74	.72	.72	.75	.78	----	----
Dust depletion	----	----	.10	.09	.09	.09	.09	.08	.06	.06	----	----
a_{0-2}:												
(Pyr.)	.61	.59	.58	.57	.52	.48	.50	.51	.54	.56	.59	.61
Dust-free air	.74	.74	.71	.70	.67	.61	.60	.60	.63	.67	.71	.73
Dust depletion	.13	.15	.13	.13	.15	.13	.10	.09	.09	.11	.12	.12

MADISON, WIS.

P (mm.)	736	737	736	735	735	736	736	737	737	737	737	737
W (mm.)	3.8	4.0	6.3	9.3	13.8	25.6	28.5	26.0	19.9	13.0	8.1	3.9
a_{0-1}:												
(Pyr.)	----	----	----	.74	.72	.71	.68	.69	.71	.72	----	----
Dust-free air	----	----	----	.80	.78	.75	.74	.75	.77	.79	----	----
Dust depletion	----	----	----	.06	.06	.04	.06	.06	.06	.07	----	----
a_{0-2}:												
(Pyr.)	.68	.69	.66	.63	.58	.58	.55	.58	.60	.61	.66	.65
Dust-free air	.76	.76	.74	.72	.69	.68	.62	.63	.66	.70	.73	.76
Dust depletion	.08	.07	.08	.09	.11	.10	.07	.05	.06	.09	.07	.11

LINCOLN, NEBR.

P (mm.)	732	732	730	729	728	728	729	729	730	730	731	731
W (mm.)	5.1	5.7	7.7	11.6	16.1	28.2	30.7	29.5	21.0	11.8	8.7	6.0
a_{0-1}:												
(Pyr)	----	----	----	.75	.73	.72	.71	.69	.73	.76	----	----
Dust-free air	----	----	----	.80	.78	.74	.74	.73	.76	.80	----	----
Dust depletion	----	----	----	.05	.05	.02	.03	.04	.03	.04	----	----
a_{0-2}:												
(Pyr.)	.70	.69	.64	.62	.59	.58	.57	.56	.61	.61	.68	.68
Dust-free air	.74	.74	.73	.70	.68	.62	.61	.61	.65	.70	.72	.74
Dust depletion	.04	.05	.09	.08	.09	.04	.04	.05	.04	.09	.04	.06

DAVOS, SWITZERLAND

P (mm.)	625	626	627	628	629	630	630	629	628	627	626	625
W (mm.)	4.5	5.2	5.9	8.1	10.5	13.6	15.6	15.5	13.1	9.1	6.7	5.0
a_{0-1}:												
(Pyr.)	----	----	.81	.81	.79	.78	.75	.78	.79	----	----	----
Dust-free air	----	----	.84	.82	.81	.80	.79	.79	.80	----	----	----
Dust depletion	----	----	.03	.01	.02	.02	.04	.01	.01	----	----	----
a_{0-2}:												
(Pyr.)	.71	.69	.67	.69	.66	.64	.65	.68	.68	.68	.68	.70
Dust-free air	.77	.76	.76	.74	.72	.70	.69	.69	.71	.73	.75	.76
Dust depletion	.06	.07	.09	.05	.06	.06	.04	.01	.03	.05	.07	.06

Depletion by atmospheric dust.—The difference between the values of a_{0-1}, or a_{0-2} as given by pyrheliometric readings and the corresponding values as computed for dust-free air by means of Figure 1 represents the depletion of solar radiation by atmospheric dust. It will be noted in Table 9 that the depletion by dust diminishes with an increase of altitude. Measurements made at the Astrophysical Observatory of the Smithsonian Institution at Calama, Chile, altitude 2,250 meters, indicates that with the sun in the zenith in the driest part of the year the depletion of solar radiation by atmospheric dust amounts to only about 3 per cent of the solar constant, and that during the remainder of the year it is inappreciable.

In connection with the construction of Figure 1 it was necessary to determine the intensity of solar radiation in different parts of the spectrum both for dry air and for air containing different amounts of water vapor. The determinations were made for sea-level conditions, B=760 mm., and also for the height of Calama, Chile, B=582 mm., $m'=\frac{582}{760}=0.766$. Having determined these intensities, it is a simple matter to compute the relative energy in the solar spectrum between different wave-length limits. For dust-free air at an altitude of 2,250 meters the results are given in Table 10, and for dust-free air at sea level, in Table 11 (A). In both tables the second column also gives the distribution of energy outside the atmosphere.

TABLE 10.—*Percentage of total energy in different parts of solar spectrum outside the atmosphere (m=0) and with a dust-free atmosphere at the altitude of Calama, Chile ($m'=\frac{582}{760}=0.766$); also depletion by atmospheric dust (depletion in total spectrum=10 per cent of solar constant)*

	Energy distribution				Depletion by dust		
Air mass (m')	0	0.766	0.766	0.766	0.766	0.766	0.766
Water-vapor content of atmosphere (cm.)	0	0	.42	1.28	0	.42	1.28
Place in spectrum	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Below 0.346μ	3.1	1.8	1.7	1.5	29.1	30.4	31.9
0.346–0.405μ	5.0	3.8	4.0	4.1	23.6	24.8	26.0
0.405–0.704μ	40.1	39.5	42.3	43.6	14.9	15.6	16.4
Above 0.704μ	51.8	54.9	52.0	50.8	7.0	7.1	7.1
Total	100.0	100.0	100.0	100.0	----	----	----
Percentage of solar constant	100.0	93.5	86.0	81.2	10.0	10.0	10.0

TABLE 11

(A) PERCENTAGE OF TOTAL ENERGY IN DIFFERENT PARTS OF SOLAR SPECTRUM AFTER DEPLETION BY DUST-FREE AIR

Solar zenith distance	0°				60°				75.7°			
Air mass	0	1			2				4			
Water-vapor content of atmosphere (cm.)	0.0	1.0	2.0	3.0	0.0	1.0	2.0	3.0	0.0	1.0	2.0	3.0
Place in spectrum	%	%	%	%	%	%	%	%	%	%	%	%
Below 0.346μ	3.1	1.3	1.2	1.0	0.7	0.6	0.5	0.3	0.1	0.2	0.1	0.06	0.02
0.346–0.405μ	5.0	3.5	3.8	3.7	3.6	2.4	2.7	2.5	2.3	1.1	1.2	1.07	1.00
0.405–0.704μ	40.1	39.3	43.3	44.2	44.9	37.6	42.3	43.4	44.2	34.0	39.7	40.4	40.9
Above 0.704μ	51.8	55.9	51.7	51.1	50.8	59.4	54.5	53.8	53.4	64.7	59.0	58.5	58.1
Total spectrum	100	100	100	100	100	100	100	100	100	100	100	100	100
Percentage of solar constant	100	90.4	80.3	76.3	73.1	84.2	69.2	65.9	61.1	75.8	58.8	51.7	45.8

(B) DEPLETION OF ENERGY BY ATMOSPHERIC DUST (TOTAL DEPLETION=10 PER CENT OF SOLAR CONSTANT)

Below 0.346μ	30.3	32.7	34.4	35.7	32.4	40.9	41.8	43.3	41.5	48.7	56.4	63.5
0.346–0.405μ	24.6	26.7	27.9	29.0	26.5	31.8	33.7	34.9	33.2	39.1	45.2	50.2
0.405–0.704μ	15.5	16.8	17.5	18.3	18.1	19.7	20.9	21.6	20.4	25.0	27.5	30.5
Above 0.704μ	6.4	7.3	7.8	8.2	6.9	9.0	9.5	11.2	8.7	11.2	13.2	15.2

(C) TOTAL DEPLETION=10 PER CENT OF INTENSITY OF DUST-FREE AIR

Below 0.346μ	27.4	26.3	26.2	26.1	27.3	29.2	27.5	26.5	31.5	28.6	29.2	29.1
0.346–0.405μ	22.2	21.4	21.3	21.2	22.3	22.7	22.2	21.3	25.2	23.0	23.4	23.0
0.405–0.704μ	14.0	13.5	13.4	13.4	15.2	14.0	13.8	13.2	15.5	14.7	14.2	14.0
Above 0.704μ	5.8	5.9	6.0	6.0	5.8	6.2	6.3	6.8	6.6	6.6	6.8	7.0

Angström[1] has recently shown that the depletion of solar radiation by atmospheric dust may be expressed by the equation $\gamma=\frac{\delta}{\lambda^{\alpha}}$. He has also found that under normal conditions the value of α departs but little from 1.28, although following the eruption of Katmai Volcano in 1912 its value was reduced about one-half. I have applied this equation to the intensities of solar radiation at different wave lengths after depletion by dust-free air, including the absorption by ozone, water vapor and other gases of the atmosphere. Table 10 and Table 11 (B) give the resulting percentages of depletion by atmospheric dust, computed for a depletion in the total spectrum amounting to 10 per cent of the solar constant. For any other percentage of depletion, as x, the percentage given in the tables must be multiplied by $\frac{x}{10}$. At Davos, in April, August and September, $m'=\frac{616}{760}=0.811$, the depletion by atmospheric dust amounts to only 1 per cent, and interpolation between Table 10 and Table 11 (B) indicates that the depletion in the different spectral regions, beginning with the shortest wave length, would be about 3.1, 2.5, 1.6, and 0.7 per cent, respectively.

On the other hand, at Washington in September, with the sun 60° from the zenith (m=2), an atmospheric water-vapor content of 2.45 cm., and a depletion by atmospheric dust of 9 per cent, the percentage depletions obtained from table 11 (B) for the different spectral regions are, respectively, 38.2, 31.0, 18.1, and 9.3.

The corresponding intensities in these spectral bands may be obtained from Tables 11 (A) and 11 (B) as follows:

Intensity below 0.346μ $=0.002\ (1.94\times0.637)(1-0.382)=0.0015$.
Intensity between 0.346μ and 0.405μ $=0.24(1.94\times0.637)(1-0.310)=0.0205$.
Intensity between 0.405μ and $0.704\mu=0.438(1.94\times0.637)(1-0.181)=0.4433$.
Intensity above 0.704μ $=0.536(1.94\times0.637)(1-0.093)=0.6008$.
Intensity in total solar spectrum with earth at mean solar distance=1.0663.

Intensity reduced to mean solar distance for September $=\frac{1.0663}{R^2}$

=1.055 gram calories per minute per square centimeter, or practically the same as in Table 7.

It must be understood that the above computation of intensities in different parts of the spectrum are for average conditions only, and take no account of the effect of variations in the ozone content of the atmosphere with both time and place, or of possible variations in the distribution of energy in the spectrum of solar radiation before it enters the earth's atmosphere. Therefore they can not take the place of careful measurements, and only serve to indicate approximately how much energy is to be expected in different spectral regions under different atmospheric conditions. The variations in the ozone content of the atmosphere must exert a marked effect upon the amount of solar energy of wave lengths below 0.346μ that reaches the surface of the earth.

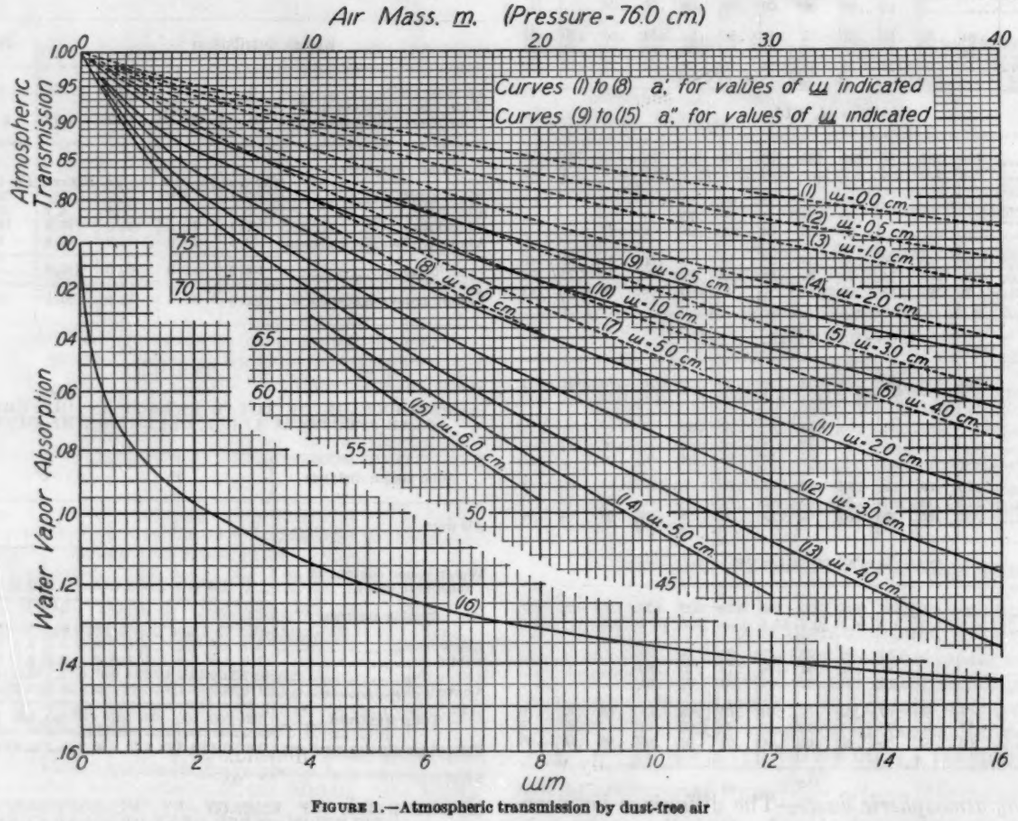


FIGURE 1.—Atmospheric transmission by dust-free air

[1] Ångström, Anders. On the atmospheric transmission of solar radiation and on dust in the air. Geografiska Annaler, 1929, H. 2.

SUMMER AND AUTUMN PRESSURE ANOMALIES AFFECTING WINTER TEMPERATURES IN THE UPPER MISSISSIPPI VALLEY[1]

By THOMAS A. BLAIR

[Weather Bureau, Lincoln, Nebr., January 7, 1930]

The region of the upper Mississippi Valley is an area in which the winters differ greatly in temperature. Some are almost continuously cold; others are moderate with only brief cold periods. The average temperature at St. Paul during the winter, December, 1874–February, 1875, inclusive, was −5.5° F.; for the winter of 1877–78 the average was 29.1° F., giving a range of 23.6° F., a range greater than the average difference between the winters at Boston and Charleston. In the 30 years from 1889 to 1919 there were eight cold winters in this region, during which the average temperature departure in the States of Minnesota and Iowa was −5° F., all but one being more than 3° below normal. In the same period there were eight warm winters with an average departure of 4.6° F., all greater than 3° F. That is to say, half the winters showed marked departures from the average. Table 1 shows the departures by months during these eight cold and eight warm winters.

TABLE 1.—*Cold and warm winters in the upper Mississippi Valley, 1889–1919*

Year	Minnesota				Iowa			
	December	January	February	Season	December	January	February	Season
1892-93	−4.4	−7.8	−5.4	−5.9	−5.2	−9.2	−6.6	−7.0
1893-94	−5.2	−2.4	.5	−2.4	−2.1	.8	−2.9	−1.4
1898-99	−3.4	.4	−7.5	−3.5	−6.0	1.3	−10.4	−5.0
1903-4	−5.5	−5.0	−9.7	−6.7	−4.5	−4.5	−7.8	−5.6
1909-10	−5.3	2.3	−4.5	−2.5	−9.0	−.4	−4.8	−4.7
1911-12	4.1	−16.2	−1.4	−4.5	3.8	−14.3	−4.5	−5.0
1916-17	−7.4	−6.5	−9.9	−7.9	−5.4	−1.5	−7.4	−4.8
1917-18	−10.1	−9.0	1.4	−5.9	−9.6	−9.9	.4	−6.3
1889-90	13.1	−1.9	3.2	3.8	11.7	−.5	2.5	4.6
1890-91	6.0	10.0	−2.6	4.5	4.4	7.5	−3.2	3.2
1891-92	9.8	−2.1	6.0	6.4	8.2	−3.2	5.5	3.5
1895-96	3.0	3.0	5.9	4.0	1.3	4.9	4.8	3.7
1905-6	5.3	7.5	1.8	4.9	2.9	6.1	1.0	3.3
1907-8	6.0	6.9	5.9	6.3	4.7	6.4	1.7	4.3
1913-14	10.8	7.4	−9.2	3.0	7.9	9.3	−5.8	3.8
1918-19	7.5	9.0	1.0	5.8	8.6	8.3	2.3	6.4

The immediate meteorological causes of these large variations are evident; a change in the paths and frequency of moving cyclonic and anticyclonic centers brings much polar air to this region one winter and much southerly air another winter. These changes in track which persist long enough to give a decided character to a month or a season are associated with changes in the pressure distribution in the North Pacific, especially with changes in the position and intensity of that "fluctuating area of low pressure in the North Pacific near Alaska," commonly called the Aleutian LOW.

The fluctuations of this area and of the pressure in the northern half of the Pacific generally are connected with slow, antecedent, and coincident world-wide changes in the general circulation. This is abundantly shown by the numerous correlations discovered by Walker, Clayton, and others, and notably by the coefficients of very high value recently calculated by Groissmayr.[2] He found a definite influence of the weather factors of India, January to October, on the following winter in Canada, getting for Winnipeg temperatures the remarkable partial correlation coefficient of 0.81.

[1] Presented before the American Meteorological Society, Des Moines, Iowa, Dec 27, 1929.

[2] F. Groissmayr, Met. Zeitschrift, May, 1929, pp. 176–180.

The warm winters are preceded by a belt of summer deficit across the Pacific, generally including a portion of the west coast of the United States or Canada, and Hawaii, the Philippines, and China, but sometimes displaced northward to include Alaska, Siberia, and Japan, with pressure above normal at Honolulu and Manila. The autumn deficit is centered over Alaska in all cases for which Alaskan data are at hand.

From year to year these areas of excess and deficiency differ enough in position and extent frequently to invalidate forecasts based on correlations or formulas using individual stations, while remaining recognizable as belonging to one or the other of these types.

These statements are descriptive of the conditions which prevailed during the 16 years examined, and are offered as indicative of the value of further investigation rather than as final precepts. Of the 14 remaining winters in the period, 1889–1919, which were not markedly abnormal as a whole, there were several types. In a few the departures were small in all three months and in both Iowa and Minnesota. In others there were large departures in one direction for a part of the winter and in the opposite direction for the remainder of the winter, sometimes beginning warm and ending cold and sometimes the reverse. In still others the departures in Iowa and Minnesota were of opposite sign. These years, presenting so many intermediate types of temperature distribution, and hence probably of pressure distribution, will be left for future discussion.

Fig. 1 shows the average departure from normal pressure in the Northern Hemisphere during the eight summers, June, July, and August, preceding the eight cold winters given in Table 1. Pressure averaged low over northern Europe and over northeastern Asia and Alaska, but a belt of moderately high pressure extended from western Europe across Iceland, Greenland, and North America, and thence westward to Hawaii, Japan, China, and central Asia. In the autumn months (fig. 2) the western deficit has shifted eastward and the Pacific area of excess has moved northward and increased, Alaska changing from deficit to decided excess. Figure 3 for the winter shows further increase and eastward drift of the Pacific center of excess, and makes evident why these winters were cold in the upper Mississippi Valley.

Similar charts for the eight warm winters (figs. 4, 5, and 6) show a distinct reversal of conditions in Pacific and polar areas for each of the seasons. In summer there is a polar area of excess very similar to the previous deficit in northern Alaska and northern Asia and a belt of subnormal pressure from the northwestern United States and western Canada to China. By autumn the deficit has moved northward and intensified, as the previously discussed excess did, and includes the northeastern Pacific, Alaska, and apparently most of the polar region. In winter the deficiency is strongly marked in all northern latitudes and is still centered over Alaska.

These two sets of maps are averages of eight nonconsecutive seasons in each case and may be assumed to represent the average or typical pressure deviations preceding and accompanying cold and warm winters, respectively; but no individual year conforms exactly with the average, and it is necessary to examine the different years to see whether these types reappear in each case.

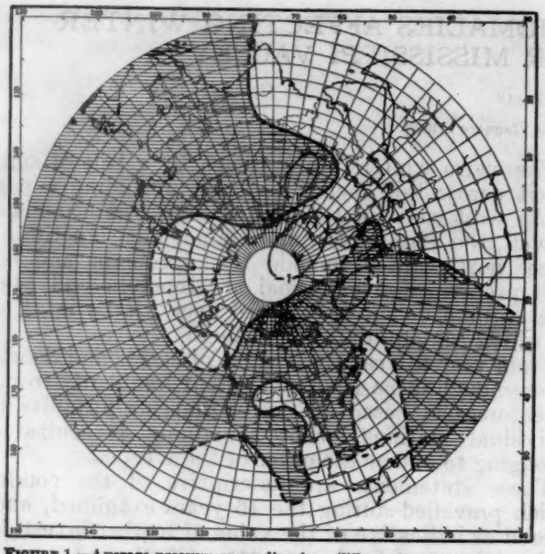


FIGURE 1.—Average pressure anomalies, in millibars, for eight summers preceding cold winters in the upper Mississippi Valley

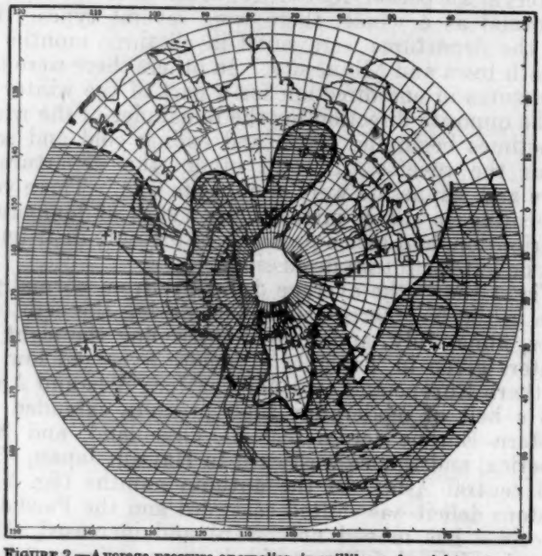


FIGURE 2.—Average pressure anomalies, in millibars, for eight autumns preceding cold winters in the upper Mississippi Valley

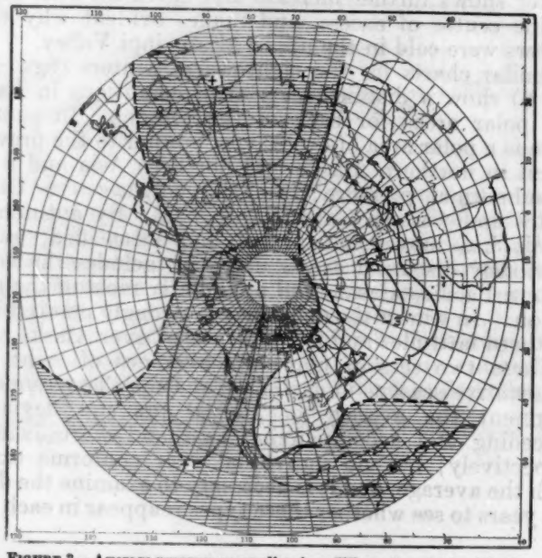


FIGURE 3.—Average pressure anomalies, in millibars, for eight cold winters in the upper Mississippi Valley

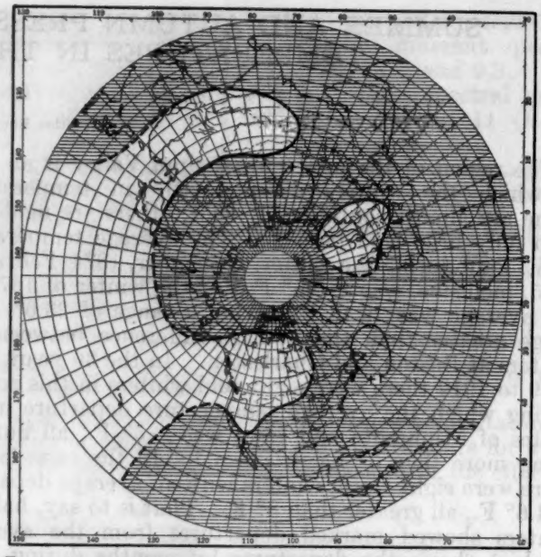


FIGURE 4.—Average pressure anomalies, in millibars, for eight summers preceding warm winters in the upper Mississippi Valley

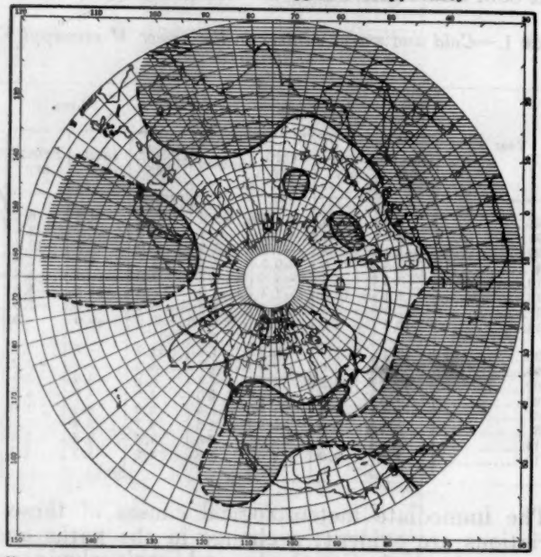


FIGURE 5.—Average pressure anomalies, in millibars, for eight autumns preceding warm winters in the upper Mississippi Valley

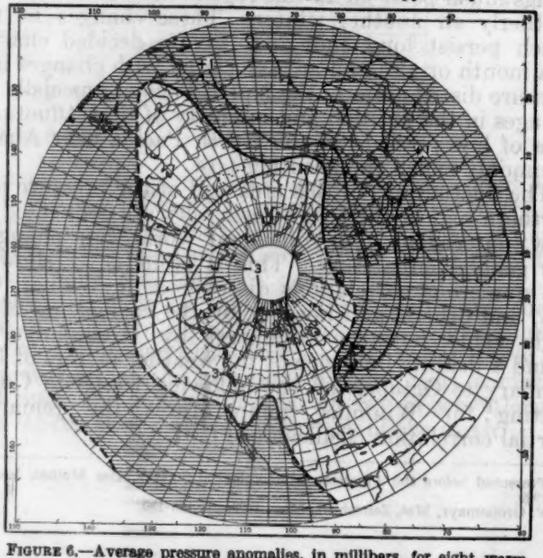
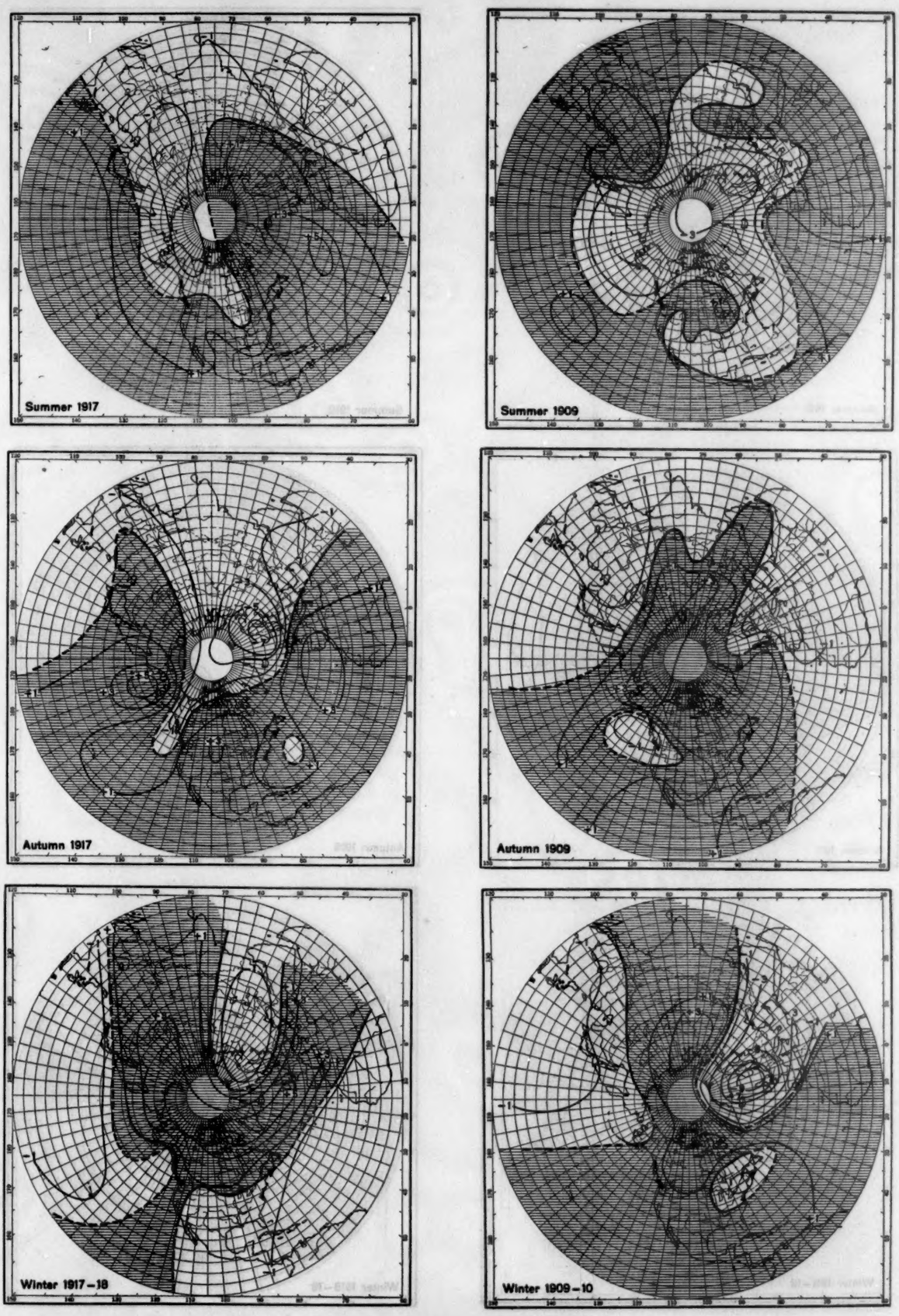
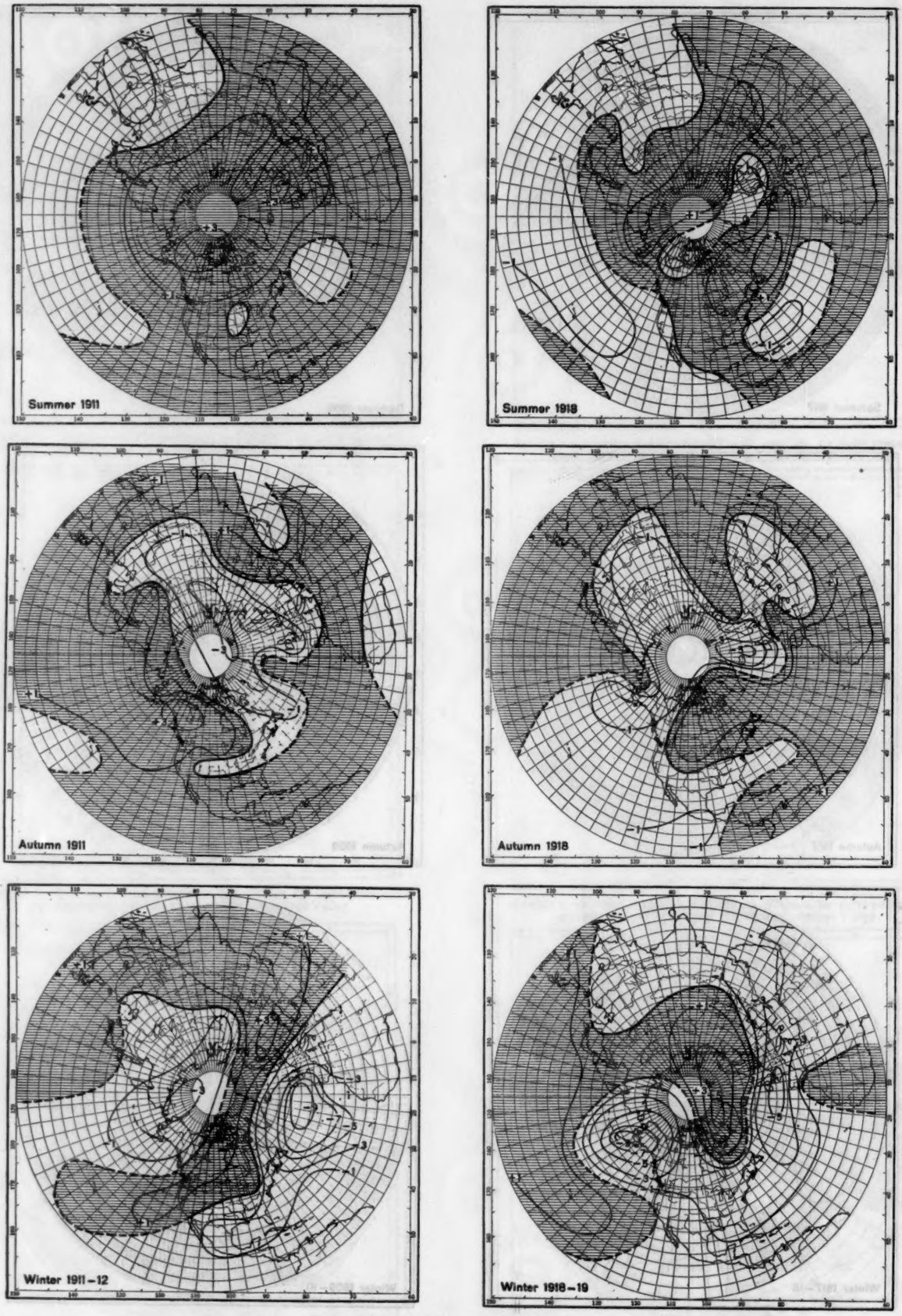


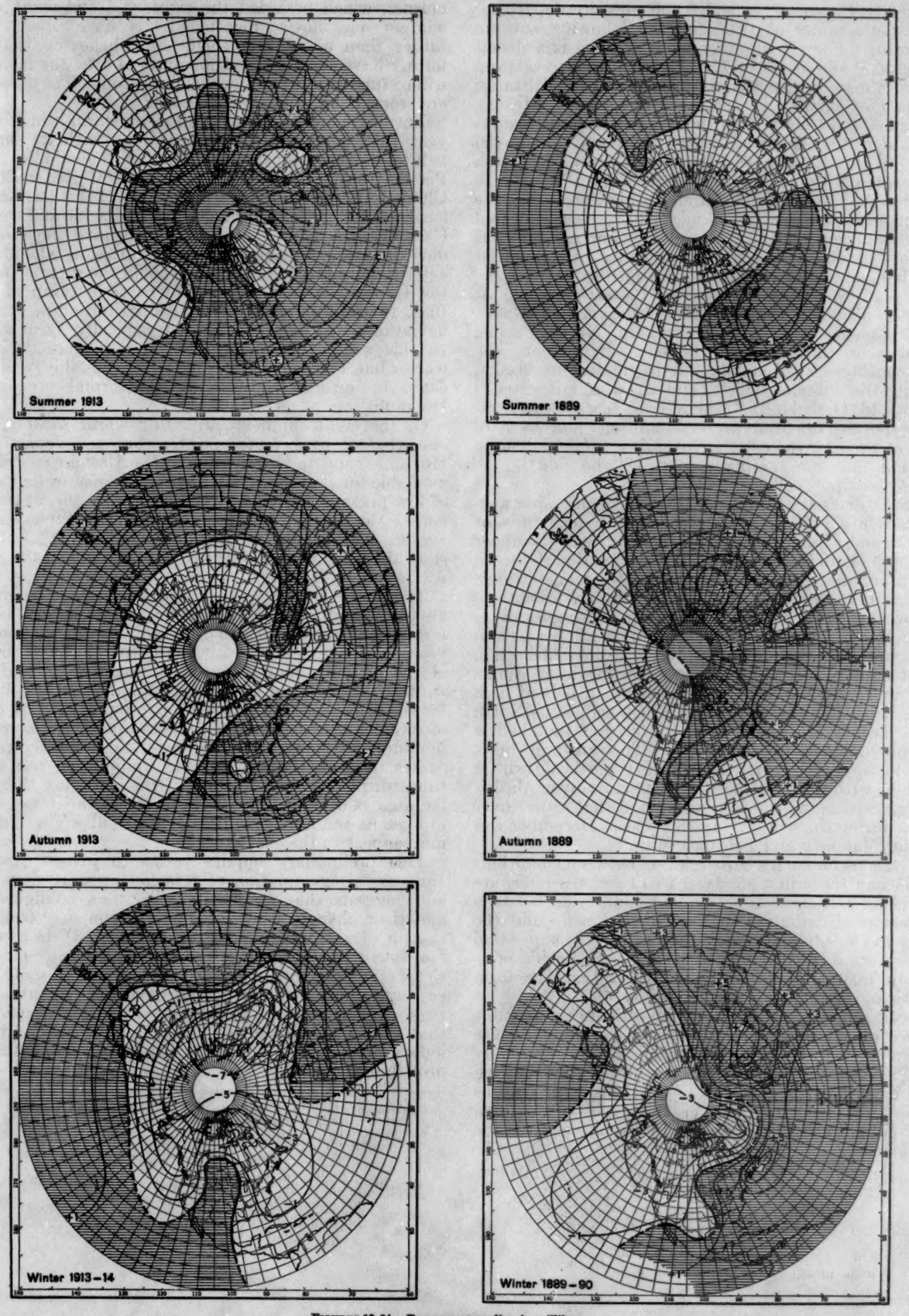
FIGURE 6.—Average pressure anomalies, in millibars, for eight warm winters in the upper Mississippi Valley



FIGURES 7-12.—Pressure anomalies in millibars



FIGURES 13-18.—Pressure anomalies, in millibars



FIGURES 19-24.—Pressure anomalies, in millibars

We have in Figures 7, 8, and 9 the pressure departures during the summer of 1917 and the following autumn and winter. For the summer months there is a deficit over Alaska and most of Canada and an excess from western Europe across the Atlantic, the United States, and the Pacific, with centers over the Azores, Mexico, and Samoa. By autumn, although the tropical regions remain high, the American center of excess has moved northward to Bismarck and the Pacific center to Dutch Harbor, while the deficit has moved from Alaska to Scandinavia. By winter the areas of high pressure have combined in polar regions, as might have been expected from the autumn map. The center of low pressure has decreased in depth and moved eastward, and another deficit has developed in the northern Pacific.

The year 1909 (figs. 10, 11, and 12) shows a similar situation. Again we have a summer deficit over Alaska and an excess over the entire middle North Pacific, greatest near the Hawaiian Islands. In autumn the excess continues at Honolulu but is greatest in Alaska, replacing the summer deficit, and by winter it extends eastward to Greenland. These two years clearly resemble the average cold winter conditions and seem to afford, at least by the end of November, a fairly definite indication that the coming winters will be cold in the upper Mississippi Valley.

There is evident in these records a considerable negative correlation between summer pressure departures at Honolulu and winter temperature departures in the upper Mississippi Valley and a positive correlation between Alaskan summer pressure and the winter temperatures. The year 1911, however, was one of the few exceptions which weakened both these correlations. Using formulas or correlation coefficients, we would predict a warm winter; but, as Figure 13 shows, the pressure distribution was not similar to that of the average warm winter, shown in Figure 4. It has, on the other hand, a belt of high pressure from the western United States across the North Pacific, as in the average cold winter, but that belt is somewhat farther to the north. The autumn map, Figure 14, approaches more nearly the typical cold-winter condition, with center of positive departure over Alaska, and Figure 15 shows the continuation of that center over Canada during the winter. In this season December was warm but January and February were cold.

The reasons for such a close relation between conditions in India and those in Canada, 2 to 12 months later, are not evident, but there is an evident connection between the pressure distribution in the North Pacific and the weather in Canada and the United States. The question naturally arises, then, Do changes in North Pacific pressure manifest themselves long enough in advance to form the basis of seasonal forecasts?

It is the object of this paper to investigate the possible influence of the average summer and autumn pressure distribution in the Northern Hemisphere, and especially in the Pacific area, upon the temperatures of the following winter in Minnesota and Iowa. It deals with seasons only and attempts to discover the types of seasonal pressure distribution, as indicated by deviations from the normal, which preceded the eight cold and eight warm winters previously mentioned. I have used maps rather than correlation coefficients, believing that the former have some distinct advantages over the latter, as will be further indicated in the discussion. The data used are from World Weather Records.[3]

Turning now to some samples of warm winters, the year 1918 offers one typical example, with its summer belt of low pressure entirely across the middle North Pacific from the western coast of the United States to China. (Fig. 16.) By autumn (fig. 17) this has become localized and intensified in the eastern Pacific and western Canada, and by winter (fig. 18) we have the strongly developed low-pressure center over Alaska, which characteristically attends warm winters in the greater part of the United States.[4] The summer and autumn of 1913 (figs. 19 and 20), show a similar distribution of pressure deviations, and Figure 21 another typically warm winter. In this winter December and January were decidedly warm, but February was cold, which possibly was indicated in autumn by the rise to normal pressure at Honolulu.

Of the eight summers preceding warm winters, only one, that of 1889, had a positive pressure departure at Honolulu, and that was small. No Alaskan records are available for that year, but Figure 22 indicates that a belt of low pressure probably extended from western America across the Pacific to Japan, as for the typical warm winter, except more northward, and Figures 23 and 24 show the development of that deficit through autumn and winter.

The maps shown are fairly representative, I believe, of all the years under consideration, so far as can be determined in the absence of Alaskan data for some of the years. They point toward some general characteristics of the pressure anomalies that precede warm and cold winters in the upper Mississippi Valley. In the figures for these 16 years the cold winters are preceded by a belt of summer excess of pressure across the Pacific, generally in middle latitudes, including the west coast of the United States, Hawaii, Japan, and the Philippines, but sometimes displaced northward. In the autumns there are large areas of excess in the north Pacific area, especially in western and northern Alaska, but small areas of deficit may appear to the eastward.

This preliminary inquiry seems to justify extended and careful examination of seasonal pressure deviations and suggests that familiarity with their configurations and their changes from season to season may lead to a system of seasonal forecasting based on their expected movement and alteration, and in that respect essentially similar in practice to the present system of daily forecasting. Such a system would have the evident advantage over a system based on correlation coefficients that each case would be considered for its individual indications rather than as an abstract statistical probability.

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[3] Smithsonian Miscellaneous Collection, Vol. 79 (whole volume), 1927.
[4] A. J. Henry, Weather Abnormalities in the United States, Third Note, M. W. R., 57, 1929, p. 204.

(To face p. 59)

FIGURE 1.—Measurements of the albedo of a snow cover

THE MEASUREMENTS OF THE ALBEDO OF A SNOW COVER

By N. N. KALITIN

Up to the present time we are in possession of a very scanty amount of data characterizing the reflective property of a land surface (bare soil, vegetative cover, water surface, snow cover), notwithstanding the great importance of this agent in thermal processes taking place in the soil and the atmosphere. This might be explained by a lack of apparatus allowing sufficiently simple and accurate measurements of the albedo of different kinds of surfaces.

Some time ago A. Ångström proposed an instrument [1] by means of which the albedo of any surface can be measured in a very simple and accurate way.

Under the term "albedo" will further be understood the amount of radiant energy reflected and expressed in per cents in respect of the direct energy.

This note is an exposition of a systematical study of the albedo of the snow-cover surface carried out in winter and spring, 1929, at the Magnetic Meteorological Observatory Sloutzk (Pavlovsk), near Leningrad.

The measurements were effected with the help of a pyranometer (A. Ångström) in connection with the loop galvanometer (C. Zeiss). Owing to the nonperiodicity and a considerable sensitivity of this galvanometer, it is especially adapted to the work conjointly with a pyranometer. The pyranometer being almost devoid of inertia and the loop galvanometer possessing a very quick receptivity, the measurements can be effected in several seconds.

For the work the pyranometer was adjusted to a special permanent installation, shown in Figure 1.

Last autumn a pillar on the top of which a brass guide tube was adjusted horizontally was sunk into the earth in an open lawn. Another brass tube, 2 meters long, was inserted into the first. On one end of this inner tube was adjusted the pyranometer so that in rotating the tube at 180° the receptive surface of the pyranometer could be placed horizontally and turned upward or downward. This placed the pyranometer above the surface of the snow cover, which remained intact during all the work. The sensitivity of the pyranometer (A. Ångström) N 29 connected to the loop galvonometer (Zeiss No.) may be determined as—, 1° of the scale of the galvanometer being equal to 0.0081 cal.

Systematical measurements of the albedo of the snow-cover surface were effected almost daily from February 16 to May 29, 1929. The snow cover having finally disappeared toward April 23, the systematical measurements effected during a whole month without the snow cover allowed us to observe the changes of the albedo accompanying the development of the vegetative cover.

Every series of measurements was formed of four readings of the galvanometer with the receptive surface turned upward and of three readings with the receptive surface turned downward. The readings were made alternately—upward, downward, upward, etc.; that supplied in the mean, five separate measurements of the albedo, the measurements of the whole series lasting four minutes.

In Table 1 is inserted a specimen of measurement of the albedo of the snow cover giving the maximum value for all the period of measurements.

TABLE 1.—*A sample of measurements of the albedo of a snow-cover surface March 11, 1929 (cloudiness, 7 Ci°°)*

Hours of observation		Reading of the galvanometer	Mean	Albedo	Mean of all measurements
				Per cent	
13h 46m	Upward	65.7			87.0 per cent.
	Downward	57.5	66.0	87.1	
	Upward	66.3	57.6	86.7	
	Downward	57.7	65.9	87.6	
	Upward	65.5	57.1	87.2	
	Downward	56.5	65.5	86.3	
13h 50m	Upward	65.5			

The mean deduced from five measurements determined the albedo of the snow-cover surface at the mediate moment of observations. The observations were suspended when there occurred precipitations (snow or rain) or when the radiation was rapidly changing owing to clouds suddenly covering or uncovering large portions of the sky or to a continued cover of clouds drifting with great speed. On some days it proved possible to effect not less than eight series of measurements; in some rare cases one a day.

In Table 2 are given the mean values deduced from all the series of observations. For the sake of abbreviation the hours and minutes of observations, as well as the state of cloudiness and of snow cover, have not been inserted into this table. As to the snow cover, some details regarding its state will be given further.

TABLE 2.—*Albedo surface of snow cover*

	Mean from all separate series of measurements								Mean of all measurements
Feb. 16	79.0	71.0	74.0	77.3	75.6	71.9			74.8
Feb. 17	79.2	77.8	79.3						78.8
Feb. 24	81.9								81.9
Feb. 25	79.7	81.8	85.0						82.2
Feb. 28	83.3	82.1							82.7
Mar. 2	78.4	78.7	80.5	82.1					79.9
Mar. 3	78.3	74.8	78.8	80.9					78.2
Mar. 4	83.3	83.1	84.5	84.7	82.7	81.9			83.4
Mar. 10	81.8	81.2	79.9						81.0
Mar. 11	82.6	82.2	82.0	84.4	85.5	87.0			84.0
Mar. 12	78.3								78.3
Mar. 14	72.6	72.7	70.8	71.4					71.9
Mar. 17	76.4	79.6	74.6	78.3	79.2				77.6
Mar. 18	68.4	71.2	72.6	72.8					71.2
Mar. 21	64.9	67.0							66.0
Mar. 22	66.6	66.0							66.0
Mar. 31	66.1								66.1
Mar. 24	80.3	80.8	79.9	79.8	80.4				80.2
Mar. 25	76.9	77.2	76.4	74.6	74.2				75.9
Mar. 26	70.1	68.2	71.1	71.6	71.7				70.5
Mar. 27	73.4	73.2							73.3
Mar. 28	59.4	59.6	57.9	54.8	58.8	58.5			58.2
Mar. 29	57.8	55.0	51.2	54.8					54.7
Mar. 30	53.5	55.7	56.4						55.2
Mar. 31	78.1	77.4	77.4	76.1	72.6				76.3
Apr. 1	77.4	76.4	77.1						77.0
Apr. 2	80.3	76.6	75.1	73.2					76.3
Apr. 3	79.6	75.1	77.1	80.0	82.6				78.9
Apr. 4	72.5	72.8	71.6	72.5	76.8	79.8			74.3
Apr. 5	74.2	70.7	71.3	67.7	69.1	66.7			70.0
Apr. 6	64.9	68.9	70.3	68.0	70.9				68.6
Apr. 7	71.5	67.5							69.5
Apr. 8	66.4	66.8	69.5	68.7	72.5	74.4			69.7
Apr. 9	70.7	59.3							65.0
Apr. 10	61.3	63.0	62.1	58.4	58.5				60.7
Apr. 11	60.8	56.7							58.8
Apr. 12	57.4	53.9	53.2						54.8
Apr. 13	47.9	60.6							54.2
Apr. 14	45.4	46.1	46.3	48.0					46.4
Apr. 15	75.3	69.0							72.2

[1] *A. Ångström.* A new instrument for measuring sky radiation. MONTHLY WEATHER REVIEW. 1919, No. 4.

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TABLE 2.—*Albedo surface of snow cover*—Continued

	Mean from all separate series of measurements								Mean of all measurements
Apr. 16	74.3	75.4	68.2						72.6
Apr. 17	79.2	71.5	71.8	70.2	66.6	63.2	60.6	58.6	67.7
Apr. 19	28.3	24.9	21.5						24.9
Apr. 21	49.6	40.6							45.1
Apr. 23	18.4	23.9							21.2
Apr. 28	20.7	18.0	18.5						19.1
Apr. 29	17.9	16.5	18.5						17.6
May 2	18.0	20.7	22.0	22.1	21.7				20.9
May 4	18.6	17.1	18.8	19.4					18.5
May 5	19.2	(14.9)	(14.0)						19.2
May 6	20.3	22.2	21.7	19.0					20.8
May 8	21.3	21.4	22.2	24.7					20.8
May 9	19.7	22.9	21.5	16.3					20.1
May 11	(17.8)	20.5	20.1	19.6					20.0
May 12	22.3	20.0	17.8	17.3					19.3
May 13	22.5	23.8	18.1						21.5
May 16	22.9	20.9							21.9
May 18	21.0	19.8	20.6						20.5
May 19	22.0	18.2	19.9	21.0	24.3				21.1
May 20	21.1	23.2	22.5						22.3
May 22	22.9	21.4	23.1	20.1					21.9
May 23	24.3	22.9	20.6						22.6
May 26	22.9	23.4	22.4						22.6
May 29	25.3	26.9	22.5	(33.2)	25.7	(37.2)			24.9

The last column of Table 2, giving the mean albedo for each day when the measurements were effected, has been graphically presented in Figure 2.

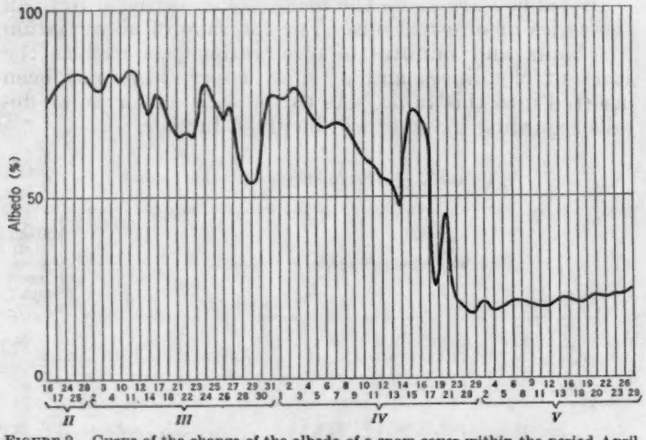

FIGURE 2.—Curve of the change of the albedo of a snow cover within the period April 16–23, inclusive, and of soil covered with grass, May 24–29, inclusive

From Figure 2 it becomes clear that in the presence of the snow cover the albedo will show rapid and considerable changes. The reflective capacity of the snow cover depends upon its form and state. The newly fallen mellow snow possesses a more important albedo than the snow of some days' old;[1] the winds and thaws that increase the density of the surface of the snow cover decrease the value of its albedo.

The fluctuations of the rate of the albedo seen so distinctly in Table 2 may be explained either by the recent fall of snow (the albedo keeping to its high rate or increasing) or by thaws (decreasing albedo), when the thawing of the upper surface of the snow cover considerably reduces its reflective power.

In order to explain the ups and downs of the curve in Figure 2, it is necessary to know the conditions which could have effected the albedo, particularly the moments of snowfall and thaw. (Table 3.)

[1] *A. Ångström*, The albedo of various surfaces of ground. Geografiska Annaler, 1925. No. 4.

TABLE 3.—*The conditions controlling the state of the snow cover*

Days with snowfall:
February 19, 22, 23, 27.
March 1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 15, 16, 17, 18, 24, 26, 28, 29, 31.
April 1, 12, 14, 15, 18, 21, 22, 24, 27, 29.

Days when the diurnal mean of air temperature was above 0°:
February: None.
March 12, 13, 14, 20, 21, 22, 23, 27, 28, 29.
April 12, 13, 14, 18, 19, 20, 23, 25, 26, 27, 28, 29, 30.

The sinuosities of the curve may be explained by means of their confrontation with the values of Table 3.

Thus up to March 12 there occurred no thaws and the albedo remained almost at the same level; in the meantime occurred frequent snowfalls and the fresh fallen snow maintained the reflective power of the snow cover almost at one level. The small decrease of the albedo on March 3 may be explained by the fact that the temperature of the air rose above 0° and apparently somewhat affected the condition of the snow cover.

Three days of thaws (March 12, 13, and 14) reduced the albedo from 84 to 72 per cent the snowfalls on the 15th, 16th, and 17th raised it again to 78 per cent. The next four days with thaws (March 20, 21, 22, and 23) decreased the albedo anew to 66 per cent; the snowfall of March 24 increased it again to 80 per cent, etc.

The fall of the albedo down to 55 per cent on the 29th and 30th may be explained by a considerable thaw having taken place an the 27th, 28th and 29th.

Very interesting is the continued decrease of the albedo from April 3 (79 per cent) to April 14 (46 per cent), which may be explained by an absence of snowfall up to the 12th, owing to which the snow cover became denser and its reflective property was reduced; on the 12th there was a snowfall accompanied by a thaw which reduced the albedo down to 46 per cent. It has to be noted, though, that within the period April 3 to 12 the maximum temperature of the air attained more than once a value exceeding zero, which ought also to have increased the thaw of the surface of the snow cover, decreasing its reflective power. The considerable rise of the albedo on April 15 and 16 (79 per cent) has to be explained by the fresh fallen snow and the air temperature below 0°.

Places of melting of the snow cover within the region of the installation of the pyranometer commenced to appear since April 18. Till then the snow cover was continuous but rather soiled; some trees growing not very far from the installation, the thaw brought to the surface a certain amount of pine-tree needles and other incrustments.

The maximum value observed during the whole period amounted to 87 per cent having occurred on March 11 at 13 h. 48 m., with cloudiness of 7 Ci. This day the snow cover was dazzling, fresh soft snow having fallen on the eve, and its surface was sparkling the last words of this day's log in the observer's notebook being: "Eyes aching after observations," which also indicates an exclusive reflective power of the snow cover on that day.

The maximum values previously obtained having been: C. Dorno, 89 per cent; Abbot and Aldrich, 70 per cent; A. Ångström, 81 per cent.

The snow cover disappeared on April 23, and after that the measurements of the albedo were carried on during a little more than a month with the help of the same installation and at the same place. The mean albedo of the vegetative cover proved to be equal to 20.8 per cent and displayed a small though systematical increase in accordance with the development of the vegetative cover. Immediately after the snow cover disap-

peared and bared the last year dry turf, very soiled by incrustements left by the snow, the albedo was 19 per cent, 18 per cent. Further, the area of new green grass augmenting from day to day and having attained with respect to the dry grass from 80 to 90 per cent, the albedo attained 23 per cent.

It was mentioned by A. Ångström that the wet grass gives a greater value of the albedo than the dry—e. g., for dry grass he obtained 32 per cent, whereas for wet grass (after a rainfall) but 22 per cent.

Among the series of observations I have had at my disposal some were made at once without rain and with rain. The picture obtained is the following: When the sun shines and the grass is wet the obtained albedo will be greater than with dry grass; if, on the contrary, the albedo of wet grass is measured, the sky being overcast, a smaller value is obtained for wet grass than for dry turf; this is clearly seen from Table 4.

TABLE 4.—*The albedo of a wet grass cover (under rain)*

Time of observations	Albedo	Conditions of observations
		May 29, 1929
h. m.	*Per cent*	
14 27	22.5	Dry grass, no sun.
14 50	33.2	Immediately after rain, sun.
14 54	25.7	No sun.
14 59	37.2	Sun.
		May 5, 1929
9 20	19.2	No sun.
10 42	14.9	After rain.
16 40	14.0	Do.

It may be that in case of wet grass and the presence of shining sun the value of the albedo is greater owing to the crystalline reflection of sun rays. However, the observations being scarce nothing definite can be said in this respect.

AT WHAT TEMPERATURE DOES FROST OCCUR?

By W. J. HUMPHREYS

This is a familiar question most of us have answered many times, usually, perhaps, by saying that frost, in the sense of fine, feathery ice crystals, begins to form as soon as the temperature of the frosted object and the air in contact with it falls to 32° F., the well-known freezing point of pure water. We often, and properly, stress the fact that on still clear nights, the times when temperature inversions are pronounced, frost can occur on grass and other exposed surface objects, while the temperature of the free air only a few feet above the ground is several degress higher than this critical value at which, with loss of heat, water turns to ice, and, with gain of heat, ice turns to water.

That is as far into details as we usually go in answering this question, but really it is not far enough, for it omits one vitally important factor—the state of the humidity. Hoarfrost, a deposit of ice directly from the air, can not form until saturation is attained—that is, not until the temperature has fallen to the dew point, no matter how low that may be. We might, therefore, answer the question "At what temperature does frost occur?" by saying "Any temperature at or below the dew point of the air at the place of occurrence up to but not above 32° F."

The term "frost," however, has several meanings besides that given above. One of the commonest of these is "freeze," used especially in connection with injury to vegetation incident to the freezing of saps and juices. Frost in this sense, the freezing and consequent injury of vegetation, can not occur at temperatures above 32° F., since most saps are nearly all water. Neither can it occur until the temperature has fallen, certainly a little, and in some cases very much, below this point, as determined by the kind of plant and degree of concentration or dilution of the sugar and other freeze-resistant substances always present in plant liquids. But many vegetables and fruits do freeze at temperatures very little below 32° F. Also, in the spring and fall of the year, the seasons when vegetation is injured by freezing, the dew point usually is above 32° F. Hence, when vegetation is injured by freezing it is quite likely also to be covered by hoarfrost, and when covered by hoarfrost it is apt to be injured by freezing. It happens, therefore, that throughout the growing season, or from early spring to late fall, we associate the occurrence of hoarfrost with injury to vegetation, and the absence of hoarfrost with lack of injury, although, as explained, either can occur without any trace of the other.

FREQUENCIES OF TROPICAL CYCLONES, ESPECIALLY THOSE OF MINOR IMPORTANCE

By Prof. STEPHEN S. VISHER

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Most discussions of tropical cyclones are confined to severe storms because of the common emphasis on the damage done. Indeed, often all but the most destructive storms, or those with hurricane winds, are ignored by meteorologists. In recent years, however, it has been increasingly recognized that even the most severe storms commence as mere slight depressions. Furthermore, even tropical barometric depressions which are too shallow to induce much wind often yield much rainfall. Although shipping has, in general, little interest in rainfall and conditions producing it, unless strong winds occur therewith, people on the land take a different attitude toward depressions which yield rainfall and other changes of weather.

Information concerning minor tropical cyclones, depressions, or lows has become recently much more abundant, especially within areas which are now included in synoptic daily weather maps.

As one phase of a study of the effects of tropical cyclones, consideration has been given to the question of how many tropical disturbances enter mid-latitudes and affect the weather there. A preliminary article on this subject may be found in the Geographical Review of January, 1925 (**5**). In continuation of that study, more recent records have been examined, including the daily weather maps of India, the North Pacific, and Brazil.

Table I gives the average number of tropical cyclones occurring yearly in certain areas, according to the indications of recent data. The three classifications refer to the intensity of the disturbances. Hurricanes are storms which for a part of their existence were known to have been accompanied by winds of 75 miles an hour or more; gales are tropical cyclones which had some winds of gale force (32 to 75 miles per hour). Lows are distinct depressions with at least feeble cyclonic circulation, but without winds of more than 32 miles an hour, except in the thunderstorm squalls, perhaps.

TABLE I.—*Frequencies of tropical cyclones in various areas*

[Approximate number occurring in an average year recently]

	Hurricanes	Gales	Lows
Western North Pacific (110° E. to 140° E.)	10	18	30
Central North Pacific (140° E. to 140° W.)	2	4	7
Eastern North Pacific (east of 140° W.)	2	3	3
South Pacific (160° E. to 130° W.)	5	8	5
Australia and coastal seas (110° E. to 160° E.)	5	8	10
South Indian Ocean	8	5	?
Arabian Sea	2	2	2
Bay of Bengal	2	4	15
Western North Atlantic	3	2	14

Many of the data upon which the figures for the tropical cyclones with winds of gale or hurricane force are based have been summarized in this journal (**1–3**) or elsewhere (**4–8**). The sources of the large figures for the lesser tropical disturbances or LOWS in several of the areas merit special mention here. For Australia the daily weather maps covering 30 years were studied, while the author was attached to the Central Meteorological Office, Melbourne (**6**).

The figures for the more severe storms of the Far East are summarized in (**3**) and (**4**). The sources of the figures for the minor disturbances are (*a*) the annual reports of the Central Meteorological Observatory of Japan, Tokyo, for the years 1905, 1907, 1914–1918, especially 1907, and (*b*) the weekly weather reports of the Imperial Marine Observatory, Kobe, for 1920, 1921, and 1922, and (*c*) the daily weather report of the North Pacific, discussed in the next paragraph (**9**). In the annual reports the tracks of the more distinct cyclones affecting Japan are given, and for 1907 also the tracks of all the minor barometric depressions or LOWS. In the weekly weather reports for 1920–1922 there are small daily maps and also weekly summaries of the cyclonic disturbances. The tracks, in these summaries and in the annual reports, commencing within 30° of the Equator were counted. (Latitude 30° is often considered as the margin of the tropics, as, for example, by Henry (**14**).) More than 100 tropical LOWS are plotted for 1907 and an average of over 70 for 1920–1922. Hence the figures here given, 30 minor, 28 stronger cyclones, seem decidedly conservative.

The daily weather reports of the North Pacific, of the Imperial Marine Observatory, Kobe, Japan, for 1923, 1926, 1927, and 1928 show an average of 51 tropical cyclones yearly in the Western North Pacific. (See Table 2.) More than 40 of these 51 are shown on the daily maps, however, to have have been accompanied at least in part of their course by strong winds. In other words, the North Pacific maps reveal an average of more than 40 gale or hurricane producing tropical cyclones a year, during these four years, in the Far East, instead of the 28 given in Table 1. But these maps show relatively few of the more minor type of disturbance which were included in the more detailed reports for the Far East alone, referred to in the previous paragraph. Hence the first line of Table 1 is a conservative compromise between these two excellent Japanese sources of data (**9**).

The data for the Central North Pacific are from three chief sources—(*a*) the monthly accounts of cyclones in this region given in the MONTHLY WEATHER REVIEW by Hurd, in his section of the storms of the North Pacific Ocean in the monthly account on Weather of the Atlantic and Pacific Oceans. These accounts for six years were examined; (*b*) The Japanese Daily Weather Reports of the North Pacific, already referred to, for the four years 1923, 1926, 1927, and 1928. More than a third of the cyclones shown on these maps as originating east of 140° E. developed in longitudes 104° to 160° E. and moved into the Western Pacific. The others moved northward. A few storms, charted and discussed in (**2, 8**), entered the Central North Pacific, as here delimited, from the Eastern Pacific, but none such are shown on the Japanese maps, which do not in fact deal with the southeastern part of the North Pacific.

The figures for the frequency of hurricanes in the Central North Pacific is based partly on scattered accounts of violent storms in this region, summarized in (**7**).

TABLE 2.—*Tropical cyclones shown in daily weather charts of the North Pacific, developing east of the Philippine Islands (125°–160° E.)*

[Imperial Marine Observatory, Kobe]

	1923	1926	1927	1928	Average
January		1		2	0.75
February			1		.25
March	1	1		1	.75
April				1	.25
May	1	1	1	3	1.5
June	2	2	2	1	1.75
July	3	4	3	3	3.25
August	7	4	3	3	4.5
September	4	5	3	4	4.0
October	2	4	4	3	3.25
November	2	3	1	2	2.0
December		1		1	0.5
Year	22	26	19	24	22.75

TABLE 3.—*Tropical cyclones developing north of the Philippines (18° N. to 30° N.)*

[Imperial Marine Observatory charts]

	1923	1926	1927	1928	Average
January	1		3	2	1.5
February	4	3	4	3	3.5
March	3	5	4	4	4.0
April	6	2	4	3	3.75
May	1	2	2	2	1.75
June	3	1		6	2.5
July	2			2	1.0
August	1		1	1	.75
September	3		2	1	1.5
October			1		.25
November			1	3	1.0
December	1	2	2	2	1.75
Year	24	15	24	29	23.25

TABLE 4.—*Tropical cyclones developing west of the Philippines* [1]

[Imperial Marine Observatory charts]

	1922	1926	1928	Average
January			1	0.33
February	1			.33
March	1		1	.66
April	1			.33
May	2			.66
June		1	2	1.0
July			1	.33
August	2		1	1.0
September				
October				
November				
December		2		.66
Year	7	3	6	5.3

[1] 1922 from charts for the Western Pacific.

TABLE 5.—*Tropical cyclones developing in the Central North Pacific (140° E. to 140° W.)* [2]

[Imperial Marine Observatory charts]

	1923	1926	1927	1928	Average
January	2	1	3		1.5
February	2			1	.75
March	2		3	2	1.75
April			2	1	.75
May		1		1	.5
June					
July	2		1	1	.5
August	2	1	1	1	1.25
September	1	1	3	4	2.25
October	1	1	4	1	1.75
November		1	2	2	1.25
December	1	1	2		1.0
Year	13	7	21	14	13.25

[2] About one-third of these develop 140° to 160° E.

The figures for the Eastern North Pacific were obtained from sources already mentioned (**2**), supplemented by Hurd's summary of the storminess of this region in recent years (**11**). This includes storms reported by the Mexican Weather Bureau but not mentioned hitherto in the MONTHLY WEATHER REVIEW. The figures for the minor disturbances is an approximation based on accounts of abnormal wind conditions in this area. Hurd in his monthly accounts in the REVIEW mentions many minor disturbances reported by ships, which he does not include among his list of the storms of the year.

The figures for the South Pacific are based on personal studies of conditions in Fiji and other island groups (**1, 4, 12**). Weather changes in Fiji, revealed by the daily meteorological conditions for four years, suggest that several minor tropical depressions affect Fiji each year on the average (**12**).

The figures as to the severe tropical cyclones in the Western North Atlantic are from Mitchell and Henry (**13, 14**). The minor cyclonic disturbances are, however, not discussed by Mitchell, Henry, or other writers. Mitchell informs me that the weather maps of the West Indian region (not published) reveal an average of only two tropical cyclones a year which have well-developed cyclonic winds but which do not attain winds of gale force. In addition there are, he reports, a considerable number of tropical LOWS (westward moving areas of falling pressure) which do not have well-developed cyclonic circulation but which often cause much rainfall. Mitchell has not determined the average frequency of such LOWS. Hence their frequency was estimated from the number of LOWS charted by W. P. Day and others as affecting the United States each month (MONTHLY WEATHER REVIEW, Charts II and III). In the REVIEW for 1922 Day states that LOWS of the Texan, Gulf, and South Atlantic types had an average frequency during the 21 years 1892–1912 of 19 per year. During the 10 years 1919–1928 there are plotted the tracks of an average of 22.1 LOWS entering the United States from the south or passing northward near the Atlantic coast. The moderate increase shown during the last decade may reflect fuller reports, including radio reports. Since a considerable number of minor tropical cyclones do not pass northward near enough to affect the United States to merit their being shown on the daily weather maps of that country, the estimate given as the final figure in Table 1 seems conservative.

The figures for the more intense storms of the Bay of Bengal and the Arabian Sea are from Newnham (**15**) and Normand (**16, 17**). The frequency of the minor disturbances is not obtainable from Normand's atlases, however, as he specifically states that the atlas of the Bay of Bengal omits many of the numerous slight storms of the monsoon season, June to September. Newnham mentions an average of six depressions a year for the period 1900 to 1912, but the fuller reports from ships since the use of the radio has become general has more than doubled this figure. The daily weather reports for 49 months—July, 1924, to July, 1929, inclusive, except 1928—have been examined and reveal an average of about 21 tropical cyclones a year, of which, 2 a year on the average are called in the weather reports severe storms or hurricanes and 3 or 4 are called storms. The remaining 15 or 16 are called depressions or, rarely, disturbances. Table 6 gives the occurrences of these tropical cyclones for the months studied.

TABLE 6.—*Tropical cyclones of the Bay of Bengal, depressions, and storms*

[Indian Daily Weather Reports]

	1924	1925	1926	1927	1929	Average
January	(1)	1			1	0.5
February						
March		1	1			.5
April		2	1			.75
May		2	3	2	1	2.0
June		1	6	2	2	2.75
July	1	3	3	5	5	3.4
August	4	2	5	3	(2)	3.5
September	3	2	4	3		3.0
October	2	2	3	2		2.25
November	2	3	2			1.75
December		2	1			0.75
Year		21	29	17		21.15

[1] Maps for first half of 1924 not studied.
[2] Data for balance of 1929 not yet received here at date of compilation.

Only the eastern part of the Arabian Sea is included in the Indian Daily Weather Map and Report, and hence Table 7 does not include all of the tropical cyclones of that sea during the 49 months studied. Of the 4 to 8 storms and depressions shown per year in Table 7, from 1 to 3 a year entered the Arabian Sea from the Bay of Bengal. An average of about 4 tropical cyclones and depressions developed annually in the eastern part of the Arabian Sea during the period studied.

TABLE 7.—*Tropical cyclones of the eastern Arabian Sea, depressions, and storms*

[Indian Daily Weather Reports]

	1924	1925	1926	1927	1929	Average
January	1	[1]1				0.25
February						.0
March						.0
April			1			.25
May		2		1		.75
June		2			1	.75
July			1	1		.5
August	1		[1]1		(?)	.5
September			[1]2	1		.75
October		1	[1]1			.5
November		[1]1		[1]1		(0.5)
December	1	[1]1				.5
Year		8	6	4		0.52

[1] Formed in Bay of Bengal.
[2] See notes at bottom of Table 6.

In a well-known official monograph on tropical cyclones published in 1913 it is stated that there are in the world an average of 34 tropical cyclones a year. The evidence summed up in Table 1 indicates, however, that there is instead, in the regions indicated, an average of more than 90 hurricane or gale-producing tropical cyclones annually, and probably even more lesser disturbances.

Although few tropical cyclones have violent winds over a belt wider than a few score miles across, the average tropical cyclone affects the weather over a much wider belt. Even slight disturbances of the lower air often lead to convectional overturning and thunderstorms. The daily weather reports of India, for example, repeatedly credit tropical cyclonic disturbances with producing rainfall far beyond their area of inclosed isobars and cyclonic winds. Cyclones also frequently cause a widespread change in the velocity of the general winds. For example, in India the monsoon is often reported by the official forecaster to have been strengthened over a wide area on one side of a cyclonic disturbance and weakened on the opposite side, with significant affects on the amount of rainfall. Correspondingly the orographical rainfall of Hawaii, Porto Rico, and other mountainous tropical areas is very greatly influenced by even weak or remote cyclonic disturbances which strengthen or weaken the ascending winds, depending on the position of the disturbance. Accompanying even moderate changes in wind velocity are often pronounced differences in convectional overturning and hence in rainfall. Except on the slopes of the higher tropical mountains, winds which merely slowly ascend the mountains cause little rainfall as compared with those slightly stronger winds in which convectional overturning occurs.

Evidences of frequent changes of weather in tropical localities is readily obtainable, but appears to have been largely ignored, partly because they were not supposed by leading meteorologists and climatologists to exist, at least to a significant degree. Even Hann stated that in the Tropics one day is almost identically like the next. This is often true if minor changes are ignored, or in comparison to the more changeable regions of the world. But the changes of weather are significant in many places where agriculture is carried on extensively, because changes in rainfall are common. They are also significant in increasing an understanding of atmospheric circulation. When an attempt is made to discover the causes of the changes of weather of tropical localities evidence of many minor tropical cyclonic disturbances is disclosed and the effects of severe storms are seen to reach much farther than had been realized. Also it is discovered that many mid-latitude HIGHS affect tropical weather and that quite frequently in winter mid-latitude LOWS enter Tropics (18).

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TRADITION VERSUS HISTORY IN AMERICAN METEOROLOGY

ERIC R. MILLER

The claims of the biographers of Matthew Fontaine Maury that he was the founder of our national weather service have been discounted by Charles F. Brooks (1), but in trying to avoid Scylla, Brooks runs into Charybdis when he says that Cleveland Abbe's forecasting service at Cincinnati grew into the national weather service.[1]

Inasmuch as the interest in the history of science and in the lives of scientists is now increasing, it may be of interest to writers of textbooks and of encyclopedias, to learn of other claims that have no more basis than those just mentioned. The following have been extracted from sources that would naturally be regarded as of the highest authority:

James Pollard Espy "organized a service of daily synchronous observations which became subsequently the meteorological bureau of the Signal Service" (2).

"* * * the electric telegraph * * * was first employed in the United States at the suggestion of Henry, Secretary of the Smithsonian Institution, in 1849, to transmit to the Signal Service an indication of the weather at each telegraph office at the opening of business for the day" (3).

Joseph Henry "was the * * * organizer of the Weather Bureau" (4).

Joseph Henry "was the organizer of the Climatological Service, a branch of the Weather Bureau, which collects the weather observations of nearly 5,000 cooperative observers located in all sections of the United States" (5).

"He [Joseph Henry] personally organized the great system of meteorological observers with its army of voluntary observers and its daily telegraphic reports, which formed the beginnings of the present United States Weather Bureau" (6).

Cleveland Abbe. "It fell to the lot of this modest man to initiate the national systems of weather forecasting which are to-day maintained by nearly every civilized nation of importance" (7).

"To be known, for a quarter of a century, as the dean of American meteorologists; to be recognized as the chief factor in bringing about the inauguration of our national system; * * * these are no slight distinctions" (8).

The Marcellus Hartley memorial medal "awarded to Cleveland Abbe for distinguished public service in establishing and organizing the weather service of the United States" (9).

"The Smithsonian Institution * * * began a series of meteorological observations at the end of 1847." "The * * * next event * * * was the organization of the Signal Service * * * in February, 1870." "The Signal Service began to function [2] on February 9, 1870, and continued until June 30, 1891." "* * * the United States Weather Bureau, at first called the United States Signal Service, had its inception in this State [Ohio]." "In 1868, Mr. Frank A. Armstrong, local manager of the Western Union Telegraph Co., at Cincinnati * * * began the daily collecting and publishing of weather reports. This soon attracted the attention of Prof. Cleveland Abbe."

"Professor Abbe and Mr. Armstrong * * * on February 2, 1869 issued the first current weather map ever published in this country" (10).

The incident referred to in the foregoing quotations, the initiation of meteorological telegrams for the benefit of commerce and navigation as a function of the Signal Service of the Army, is easily accessible in the official records.

A memorial written by Increase A. Lapham, of Milwaukee, Wis., on December 8, 1869, and addressed to Gen. Halbert E. Paine, Member of Congress from the congressional district in which Milwaukee is located, induced Paine to prepare a bill (H. R. 602) which he introduced on December 16, 1869. Paine obtained letters in support of his bill from the following persons:

J. K. Barnes, Surgeon General, United States Army.
Joseph Henry, Secretary of the Smithsonian Institution.
Elias Loomis, professor in Yale University.
Albert J. Myer, Chief Signal Officer of the Army.

The memorial and accompanying list of marine disasters from Lapham and the letters from these gentlemen were printed as Executive Document No. 10, parts 1 and 2, Forty-first Congress, second session. In binding they became separated, the first appears in the volume bearing serial No. 1431, the second in serial No. 1416. House bill 602 becoming pigeonholed in committee, General Paine originated a joint resolution (H. J. Res. 143), which was introduced by him in the House and by Senator Wilson, of Massachusetts, in the Senate, on February 2, 1870, passed and received the signature of the President on February 9, 1870.

The execution of this act, which appropriated $25,000, was assigned by the Secretary of War to Gen. Albert J. Myer, Chief Signal Officer of the Army. The Signal Service had been organized June 27, 1860, was renamed Signal Corps on February 24, 1880, lost the civil meteorological work by transfer to the newly constituted Weather Bureau on June 30, 1891, and continues in existence to-day. Myer engaged and trained the necessary personnel, purchased instruments, arranged telegraph circuits, and started the meteorological service on November 8, 1870, when he hired Lapham as the first meteorologist of his service.

According to the usual custom in naming legislation—e. g., "Volstead Act," McKinley bill," etc.—credit for establishing the national weather service belongs to Halbert E. Paine. The initial stimulus was supplied by Increase A. Lapham, whose list of disasters on the Great Lakes furnished the "punch" that enabled Paine to put the legislation through Congress, where the "hammering" of Maury and Joseph Henry had been ineffectual.

The credit of organizing the meteorological service belongs solely to Chief Signal Officer Albert J. Myer.

No reference to Abbe or the Cincinnati observatory occurs in these records of Congress. Abbe had been studying astronomy at Poulkova when national weather services were being developed in Europe following the lead of Le Verrier at Paris, in 1862 and 1863. Abbe came to Cincinnati as director of the astronomical observatory in 1868. In 1869 he obtained promise from the Cincinnati Chamber of Commerce of financial support for three months for a telegraphic weather service. The first bulletin was issued September 1, 1869. After three months' trial the support of the chamber of commerce terminated, and Abbe maintained the bulletin for six months himself. In the meantime Mr. Armstrong, of the Western Union, began publishing a weather

[1] Brooks, C. F. Matthew Fontaine Maury, Recent biographies of, abstracted from reviews by Roscoe Nunn. Mo. Wea. Rev. 57: 472.
[2] [The writer probabably meant in an administrative sense.—*Ed.*]

map in February, 1870; and in May, Abbe's bulletin was combined with this, and continued until December, when the Signal Service office in Cincinnati began to issue weather maps (11).

In November, 1869, Lapham prepared a resolution which was introduced by the delegate from Milwaukee, Mr. E. D. Holton, at the second convention of the National Board of Trade, at Richmond, Va., on December 3. It is solely in connection with this resolution that Abbe claimed connection with the initiation of the national weather service, writing "In November, 1869, occurred at Richmond the annual meeting of the National Board of Trade. Several of the Cincinnati delegates (and especially Mr. John A. Gano, president of the Cincinnati Chamber of Commerce) had been the hearty supporters of my Weather Bulletin, and were desirous of bringing the subject to the attention of that body. Their action was, however, anticipated by that of the Hon. C. D. Holton, of Milwaukee, who presented a memorial drawn up by the Hon. I. A. Lapham" (12). The same matter was referred to later by Abbe (13, 14). This memorial led to a resolution by a subcommittee "that the executive council be empowered to recommend to Congress to afford such aid to the different observatories of the country as will enable the astronomers in charge to give the necessary time to the subject." (See p. 323 of the printed report of this convention.) There is no record of action on this resolution, and if passed the executive committee failed to avail itself of the power conferred upon it. The text of all memorials and addresses to Congress and to State legislatures is given in full at the end of the report of the convention, and there is no reference to this subject. It must be inferred that Abbe had no overt connection with the initiation of our national weather service.

The history of the connection of the Smithsonian Institution and of Joseph Henry with American meteorology was long and important. The annual reports of the Secretary supply the data for the following brief summary. The institution was organized in 1847, with a program giving a large place to meteorology. In 1849, with funds appropriated at the last meeting of the regents in the preceding year, 216 observers were equipped and began reporting. Presidents of telegraph companies were asked, in 1849, and agreed to transmit weather reports free of charge, but this service did not begin until 1856 or 1857. A map with iron pins to which were attached colored disks to show the "face of the sky" was displayed as a museum exhibit for the amusement of visitors to the institutions, and daily reports were tabulated and furnished to the Washington Evening Star for publication. These reports were obtained from two lines, one running from New York to New Orleans and the other from Washington to Cincinnati. The service ceased in 1861, except for an ineffectual attempt to resume it in 1862. The corps of voluntary observers, reporting by mail, reached at most 500, but diminished greatly during the war. Henry asked General Myer to take these observers over in 1872, and this was accomplished in 1874. They were continued without change until Myer died and was succeeded by W. B. Hazen as Chief Signal Officer in 1881. In that year Hazen addressed the governors of all the States a circular letter urging the establishment of State weather services. This was afterwards placed in the hands of H. H. C. Dunwoody, who traveled throughout the country organizing what has now become the climatological service of the Weather Bureau. The credit for this development, beginning in 1881, should go to Hazen and Dunwoody.

The official history of James Pollard Espy is somewhat obscure. He obtained an international reputation by the publication of his book The Philosophy of Storms. Afterwards he was employed under the direction of the Surgeon General of the Army, and still later under the Secretary of the Navy. Four reports from his pen were published in 1843, 1849, 1851, and 1857. The last of these marks the end of his connection with the Government, and he died about the time that the Signal Service was organized, in 1860, and 10 years before the Signal Service was concerned with meteorology. Espy organized a corps of observers, numbering 163, in his second report. Joseph Henry records in his annual reports that he had obtained the cooperation of Espy. Thirty of Espy's reporters are also listed in the first Smithsonian list in 1849, and after the termination of Espy's work his observers were absorbed into the Smithsonian corps of observers. Lapham was one of these, and the complete file of his observations, on file in the Wisconsin Historical Society, show that he ultimately became a cooperative observer under the Signal Service, when the Smithsonian observers were transferred in 1874.

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NOTES, ABSTRACTS, AND REVIEWS

Dust fall at Portland, Oreg.—On the morning of January 17 there was observed in Portland a very unusual deposit of dust. It covered the snow which lay on the ground at that time, giving it a reddish brown color. It lay on the pavements in such quantities that persons coming into the office from the street left tracks on the office floor at every step. The accumulation of dust on desks and tables in the office was so thick that it was possible to write with the finger anywhere. The dust was so fine as to enter around closed windows. It was entirely different in appearance from the soil found west of the Cascade Mountains, more nearly resembling the volcanic soil of the arid interior.

Investigation showed that all of Oregon was covered by snow at the time, for the deposit occurred during the memorable cold period; therefore the investigation was carried into Washington, and it was learned that severe dust storms occurred in several counties of eastern Washington on the 16th. Prevailing winds were from the north and east and carried the dust over the snow-covered regions in northern Oregon, as shown on the inclosed sketch, which outlines the area over which dust was observed on the dates mentioned. (Not reproduced.)

It will be noted that the dust was not carried to a sufficiently high level to take it over the Cascade Mountains but that enough came through the Columbia Gorge, carried by a strong east wind, to reach Portland and as far as Forest Grove, about 30 miles west of Portland. In places near the mouth of the Columbia Gorge, east of Portland, the dust deposit was sufficiently heavy so that when the snow had partly melted the dust made a solid coating, hiding the snow banks entirely.

At this station the wind was mostly from the east on the dates mentioned, the average velocity for the two days being 16.3 miles an hour. Through the Columbia Gorge the velocity was undoubtedly much greater than this.—*Edw. L. Wells.*

Rudolph Meyer, Die Haloerscheinungen (viii, 168 pp., Hamburg, 1929).—This volume is No. 12 in the useful series *Probleme der Kosmischen Physik;* the intention of editors to have it written by E. Barkow was frustrated by the untimely death of the latter, but a worthy substitute was found in Meyer, of Riga, who was already known in this field through his previous publications on halos.

As the author remarks in his preface, the subject of halos is, in its entirety, a very extensive one, and a work of this character must necessarily be incomplete. An effort has been made to interest and instruct as wide a circle of readers as possible, rather than to write for the specialist only. The book is entirely nonmathematical.

The author has succeeded in summarizing a large amount of information and opinion concerning a very wide range of topics and has produced a valuable supplement to the already existing treatises on halos. Many of the observed halos which are described are not to be found in the standard current reference works on meteorological optics. It should be noted that the Boulder halo, figured on page 101, was observed in January instead of in June.—*Edgar W. Woolard.*

The great frost in British Isles of February, 1895.—In the issue of Nature (London) of February 8, 1930, there appears under the title Historic Natural Events an account of what is called the great frost of the early part of 1895 in the British Isles.

The greatest intensity of the cold was experienced during the period January 26 to February 19, 1895, when an absolute minimum of −17° F. was registered at Braemar and —11° F. at Buxton. The great frosts, as periods of low temperature are called in Great Britain, was the most severe in that country since 1813–14, but in Europe the winter, though severe, was not so rigorous as in 1879–80.

It so happened that February, 1895, was exceptionally cold in the central, southern, and eastern parts of the United States. The average departure from the normal for the East Gulf States was −13.3° F. and for individual stations a greater amount. While the primary cause of the low temperatures in both countries was the prevailing pressure distribution, the final results were brought about in a somewhat different way. In England the prevailing winds were from the east, due to strong anticyclones moving toward the east across Scandinavia, and in the United States the cold winds were from the northwest, due to the southeastward movement of strong anticyclones. A single strong anticyclone with central pressure above 31 inches on three consecutive maps dominated the weather in the early days of the month; and a ridge of high pressure, or wind divide, prevailed from the 6th to the 16th, and at the same time pressure was low in the northeastern part of the country, thus prolonging and intensifying the drift of cold continental air toward the Gulf of Mexico and the Atlantic.

The occurrence of large temperature anomalies in the same sense at widely separated parts of the globe is perhaps to be expected.

As we have already seen, the pressure distribution for the time and place was apparently responsible for the low temperatures, but we should like to go a step farther and inquire why should anticyclonic pressure conditions so thoroughly dominate the weather at some places and in some parts of the globe and not in others?—*A. J. H.*

New Arctic weather stations.—The Russian ice breaker *Sedov* left Archangel last July, carrying the staff, building materials, supplies, and equipment for the world's most northerly weather station, which was established the following month at Calm Bay, Hooker Island, Franz Josef Land, in latitude 80° 19′ N., longitude 52° 48′ E. The staff of seven men is to be relieved annually, provided ice conditions permit a ship to reach them, and the station is provisioned for three years. The station reports its observations by radio, using a short-wave transmitter, and is also equipped for long-wave reception. Pilot-balloon observations form part of its program for the present year. Later more extensive scientific work will be undertaken and an airplane will be added to the equipment.

The earliest meteorological observations in Franz Josef Land were those taken by the Austrian expedition of 1873–74, under Weyprecht and Payer, and some series have been taken by later expeditions, but none between the year 1914 and last summer. The first radiogram was sent from the new station on August 30, 1929.

Similar radio stations were established last summer by the Russians at Wrangel Island and at Bulun (latitude 70° 45′), on the River Lena, making a total of 11 Russian stations at which weather observations are taken and reported by radio the year round on the shores and islands of the Arctic Ocean.—*C. F. Talman, in Why the Weather, Science Service, Washington, D. C.*

Meteorological summary for Chile, January, 1930 (by J. Bustos Navarrete, Observatorio del Salto, Santiago, Chile.—The diminution in activity of solar radiation coincided with a noticeable weakening of atmospheric circulation over the South Pacific. The number of depressions was very small, and the paths of these were shifted very much toward the south. Unsettled weather and rains were generally limited to the southern part of the continent between Magallanes and Chiloe; in the remainder of the country, from Valdivia northward, conditions were very stable.

Temperatures were not very high in the central zone, rarely exceeding 86° to 90° F., in contrast to much higher readings in previous years.

On the central and northern coasts the mornings were frequently cloudy or foggy.

The only anticyclonic centers worth mentioning were those charted on the 6th, 12th, 15th, and 25th and moving for the greater part from latitude 40° to 45° S. toward Argentina.—*Translated by W. W. R.*

Death of Dr. L. Coussirat de Araujo in charge of the meteorological service of Rio Grande do Sul, Brazil.—We regret to learn of the death in February of this year of Prof. Dr. Ladislau Coussirat de Araujo in his fortieth year. Doctor Araujo at the time of his death was the director of the Instituto Astronomico e Meteorologico, Escola Engenharia, of Porto Allegro, Brazil. He was a distinguished civil engineer with strong leanings toward meteorology and was in charge of the meteorological service of the State of Rio Grande do Sul. His meteorological education was received in France, England, and the United States.—*A. J. H.*

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C. FITZHUGH TALMAN, in Charge of Library

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING FEBRUARY, 1930

By HERBERT H. KIMBALL, Solar Radiation Investigations

For reference to descriptions of instruments and exposures, and an account of the method of obtaining and reducing the measurements, the reader is referred to this volume of the REVIEW, page 26.

Table 1 shows that solar radiation intensities were close to the normal intensity for February at Washington, D. C., and slightly below at Madison, Wis., and Lincoln, Nebr.

Table 2 shows a deficiency in the total solar radiation received on a horizontal surface directly from the sun and diffusely from the sky at Madison, Lincoln, New York, Fresno, and La Jolla, and an excess at Washington, Twin Falls, and Chicago, as compared with the normal amount received at the respective stations in February.

No skylight polarization measurements were obtained at Madison during the month. At Washington measurements obtained on four days give a mean of 63 per cent and a maximum of 66 per cent on the 10th. These values are slightly above the corresponding averages for February at Washington.

TABLE 1.—*Solar radiation intensities during February, 1930*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Feb. 10	2.26			1.24	1.35		1.29				1.96
Feb. 11	1.88	0.64	0.83	0.96	1.19		1.81				1.96
Feb. 12	3.45	0.49	0.62	0.81	0.88		1.17	0.93	0.57		3.30
Feb. 14	3.30	0.75	0.88	1.10	1.23		1.27	1.10	0.99	0.88	2.49
Feb. 27	9.83			0.88	1.11						4.95
Means		0.63	0.78	1.00	1.15		1.23	(1.02)	(0.78)	(0.88)	
Departures		−0.07	−0.02	+0.03	−0.02		+0.04	+0.05	−0.06	+0.12	
Madison, Wis.											
Feb. 8	2.06			1.07	1.23						2.74
Feb. 10	1.52			1.13			1.33	1.20			1.37
Feb. 13	1.78			1.15	1.37						1.96
Feb. 14	0.86			1.10							0.91
Feb. 15	0.43			1.14	1.41						0.69
Feb. 19	5.16			0.90	1.12						3.63
Feb. 26	3.99			1.11	1.29						3.81
Means				1.09	1.28		(1.33)	(1.20)			
Departures				−0.12	−0.09		−0.04	+0.02			
Lincoln, Nebr.											
Feb. 1	4.17		0.89	1.05							4.95
Feb. 10	2.62						1.30	1.11	0.95	0.81	3.30
Feb. 17	4.57		1.06	1.21	1.38						5.79
Feb. 19	5.16		0.98	1.12							6.27
Feb. 26	3.45		1.07	1.24	1.36		1.32	1.11	0.99	0.88	3.45
Means			1.00	1.16	(1.37)		(1.31)	(1.11)	(0.97)	(0.84)	
Departures			−0.04	−0.03	−0.01		−0.05	−0.05	−0.06	−0.08	

[1] Extrapolated.

TABLE 2.—*Total solar radiation (direct+diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning	Average daily totals: Washington	Madison	Lincoln	Chicago	New York	Pittsburgh	Gainesville	Twin Falls	Fresno	La Jolla
1930	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 29	160	170	219	105	29	[1] 90	293	228	266	280
Feb. 5	221	206	273	137	142	[2] 148	292	277	322	186
Feb. 12	242	219	250	126	145	[3] 205	273	394	368	250
Feb. 19	279	199	268	152	155	163	439	249	251	289
	Departures from weekly normals									
Jan. 29	−39	−21	−8	−3	−58			+13	+4	+33
Feb. 5	+18	−3	+13	+25	+13			+11	+8	−61
Feb. 12	+16	−10	−32	−2	+5			+97	+23	−5
Feb. 19	+22	−51	−36	−3	−19			−40	−110	−57
Accumulated departure, Feb. 26	−623	−602	−161	+476	−581			+2103	−421	+1778

[1] 5-day mean. [2] 4-day mean. [3] 6-day mean.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. C. S. Freeman, Superintendent U. S. Naval Observatory. Data furnished by Naval Observatory in cooperation with Harvard, Yerkes, Mount Wilson, and Perkins observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic: Diff. long.	Longitude	Latitude	Area: Spot	Group	Total area for each day
1930	*h m*	°	°	°			
Feb. 1 (Naval Observatory)	12 25	−77.0	6.7	−7.0		247	
		−47.0	36.7	+19.5		231	
		−21.0	62.7	+6.5	123		
		+34.5	118.2	+17.0		154	
		+66.0	149.7	+11.0		77	832
Feb. 2 (Mount Wilson)	12 20	−80.0	350.7	+8.0		238	
		−80.0	350.7	−3.0	14		
		−80.0	350.7	−13.0		20	
		−64.0	6.7	−8.0		223	
		−35.0	35.7	+21.0		205	
		−8.0	62.7	+8.0	113		
		+0.5	71.2	−5.5		17	
		+50.0	120.7	+19.0		144	974
Feb. 3 (Naval Observatory)	11 23	−71.5	346.5	−12.5	31		
		−69.5	348.5	−18.0		93	
		−66.0	352.0	+8.0	216		
		−65.5	352.5	−3.5	25		
		−50.5	7.5	−7.0		262	
		−48.0	10.0	+15.5	6		
		−25.0	33.0	+13.0	6		
		−22.0	36.0	+20.0		231	
		−8.0	50.0	−12.0		9	
		+5.0	63.0	+8.0		77	
		+13.5	71.5	−5.0		106	
		+61.5	119.5	+17.5		170	1,234
Feb. 4 (Yerkes)	17 18	−71.5	330.1	−13.0	23		
		−61.0	340.6	−12.5	25		
		−56.5	345.1	−20.0	88		
		−49.5	352.1	−19.5		168	
		−48.5	353.1	+7.0		220	
		−47.5	354.1	−3.5	36		
		−36.5	5.1	−8.0		105	
		−29.5	12.1	−7.5		83	
		−9.0	32.6	+12.0	7		
		−6.0	35.6	+20.0		217	
		+7.0	48.6	−14.0	61		
		+11.0	53.6	−12.0	49		
		+21.5	63.1	+7.5		78	
		+27.0	68.6	−5.0	13		
		+33.5	75.1	−4.5	19		1,192
Feb. 5 (Naval Observatory)	11 24	−52.5	339.1	−13.0		170	
		−41.5	350.1	−18.5		216	
		−38.5	353.1	+7.5		216	
		−37.5	354.1	−3.5	12		
		−25.0	6.6	−6.5		170	
		−1.0	30.6	+12.5	3		
		+4.0	35.6	+19.5		123	
		+19.5	51.1	−12.5		185	
		+32.0	63.6	+7.5		77	
		+40.5	72.1	−5.5		22	1,194
Feb. 6 (Mount Wilson)	13 50	−46.0	331.2	−13.0		61	
		−37.0	340.2	−13.0		50	
		−28.0	349.2	−19.0		143	
		−24.0	353.2	+9.0		157	
		−23.0	354.2	−3.0	22		
		−10.0	7.2	−10.0		89	
		+20.0	37.2	+21.0	71		
		+33.0	50.2	−13.0		233	
		+48.0	65.2	+8.0	87		913
Feb. 7 (Naval Observatory)	13 23	−26.0	338.2	−13.0		170	
		−12.5	351.7	−19.0		231	
		−11.5	352.7	+8.0		93	
		−10.0	354.2	−4.0	15		
		+1.5	5.7	−6.5		31	
		+32.5	36.7	+19.0	108		
		+46.5	50.7	−12.5		309	
		+59.5	63.7	+7.0		77	
		+71.5	75.7	−3.5	123		1,157
Feb. 8 (Naval Observatory)	11 25	−72.5	279.6	+13.0		22	
		−12.0	340.1	−14.0		170	
		+1.0	353.1	−19.0		370	
		+1.0	353.1	+8.0		139	
		+2.5	354.6	−4.0	12		
		+15.0	7.1	−7.5		77	
		+45.0	37.1	+19.5	108		
		+59.5	51.6	−12.5		293	
		+74.0	66.1	+8.0	62		1,253

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
	h m	°	°	°			
Feb. 9 (Naval Observatory).	10 43	−59.5	279.8	+13.0		46	
		−19.0	320.3	+13.5		34	
		+1.0	340.3	−14.0		93	
		+13.5	352.8	+8.5		77	
		+14.0	353.3	−19.0		340	
		+16.5	355.8	−4.0	12		
		+29.0	8.3	−7.5		22	
		+58.5	37.8	+20.0	108		
		+73.0	52.3	−13.0		216	
		+86.0	65.3	+8.0	62		1,010
Feb. 10 (Naval Observatory).	11 20	−44.0	281.8	+12.5		31	
		−6.0	319.8	+13.0		31	
		−2.5	323.3	−3.0		46	
		+6.5	332.3	−12.0	3		
		+26.5	352.3	+8.0		93	
		+29.5	355.3	−18.5		324	
		+29.5	355.3	−3.5		15	
		+72.5	38.3	+20.0	108		
		+81.5	47.3	−13.5	62		713
Feb. 11 (Naval Observatory).	11 26	−33.0	279.6	+13.5		108	
		+13.0	325.6	−3.5		62	
		+40.5	353.1	+8.5		77	
		+44.0	356.6	−3.0	12		
		+45.0	357.6	−18.0		494	753
Feb. 12 (Naval Observatory).	11 26	−19.0	280.5	+13.0		123	
		+53.5	353.0	+8.5		77	
		+59.0	358.5	−17.0		432	632
Feb. 13 (Yerkes)	11 22	−16.0	270.3	+11.0		100	
		+68.0	354.3	+9.0	32		
		+71.0	357.3	−18.0		622	754
Feb. 14 (Naval Observatory).	11 28	−76.0	197.1	+18.0	15		
		−70.0	203.1	+13.5		62	
		+8.0	281.1	+13.0		170	
		+54.0	327.1	−3.0		18	
		+87.0	0.1	−17.5		123	388
Feb. 15 (Mount Wilson).	13 30	−57.0	201.8	+13.0		20	
		+2.0	260.8	−12.0		7	
		+21.0	279.8	+12.0		61	
		+69.0	327.8	−5.0		10	98
Feb. 16 (Naval Observatory).	11 25	−42.0	204.8	+13.0		77	
		+35.0	281.8	+13.5		62	139
Feb. 17 (Naval Observatory).	11 29	−27.0	206.6	+12.0		123	
		+5.5	239.1	−8.5	6		129
Feb. 18 (Naval Observatory).	10 31	−14.0	206.9	+12.0		216	216
Feb. 19 (Naval Observatory).	11 13	+2.0	209.4	+11.5	77		77
Feb. 20 (Naval Observatory).	11 19	+14.5	208.7	+12.0		93	93
Feb. 21 (Naval Observatory).	11 22	+29.0	209.8	+12.0	62		62
Feb. 22 (Naval Observatory).	10 35	−87.0	81.2	−6.0	185		
		+40.0	208.2	+12.5		93	278

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
	h m	°	°	°			
Feb. 23 (Mount Wilson).	12 0	−71.0	83.2	−5.0	228		
		−26.0	128.2	−7.0		8	
		+56.0	210.2	+11.0		56	292
Feb. 24 (Naval Observatory).	11 12	−60.0	81.6	−5.5		262	
		+67.5	209.1	+12.0		77	339
Feb. 25 (Naval Observatory).	11 20	−47.5	80.8	−5.5		309	
		+10.5	138.8	−2.5	3		312
Feb. 26 (Naval Observatory).	13 50	−32.5	81.3	−5.0		278	278
Feb. 27 (Naval Observatory).	11 28	−19.5	82.4	−5.5		293	293
Feb. 28 (Naval Observatory).	11 8	−83.5	5.4	−15.0	494		
		−6.0	82.9	−5.0		201	
		+9.0	97.9	+11.0	2		697
Mean daily area for February.							582

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR FEBRUARY, 1930[1]

[Data furnished through the courtesy of Prof. W. Brunner, University of Zurich, Switzerland]

February, 1930	Relative numbers	February, 1930	Relative numbers	February, 1930	Relative numbers
1	[a] 48	11	E [b] 79	21	10
2	73	12	55	22	13
3	[c] 98	13	47	23	[a] 18
4	M [b] 111	14	[c] 37	24	20
5	[c] 117	15	E [b] 36	25	16
6	110	16		26	15
7		17		27	19
8	[c] 84	18	23	28	[a] 26
9	101	19	[c] 18		
10	66	20	8		

Mean, 25 days = 49.9.

[1] Dependent alone on observations at Zurich and its station at Arosa.
[a] = Entrance of a large or average-sized center of activity on the east limb.
[b] = New formation of a large or average-sized center of activity: E, on the eastern part of the sun's disk, W, on the western part, M, in the central zone.
[c] = Passage of an average-sized group through the central meridian.

AEROLOGICAL OBSERVATIONS

By RICHMOND T. ZOCH

Free-air temperatures were above normal at all levels at all stations. (Table 1.) Practically all of the departures were very large, except Due West.

Free-air relative humidities were below normal at all levels at Due West and Royal Center and in the upper levels at Groesbeck. At Broken Arrow and Ellendale they were above normal at most levels.

Free-air vapor pressures were above normal at all levels at Broken Arrow, Ellendale, and Royal Center and in the lower levels at Groesbeck. At Due West and in the upper levels at Groesbeck they were below normal.

From the surface to the 1,500 meter level the free-air resultant winds were variable. Above this level they were westerly. (Table 3.)

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during February, 1930*

TEMPERATURE (°C.)

Altitude m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters										
Surface	10.3	+5.4	8.4	+0.3	−3.1	+6.6	13.7	+3.9	3.3	+4.8
500	10.3	+6.5	8.6	+1.4	−3.3	+6.4	12.6	+4.0	1.8	+5.3
1,000	8.9	+5.9	6.8	+1.2	−1.8	+6.8	12.0	+3.7	0.2	+4.7
1,500	7.2	+5.1	4.6	+0.9	−2.3	+5.8	10.4	+3.3	−1.6	+3.8
2,000	4.8	+4.3	2.5	+0.7	−4.8	+4.7	8.5	+3.4	−3.6	+3.2
2,500	2.0	+3.8	0.3	+0.9	−7.7	+4.1	6.3	+3.6	−5.6	+3.1
3,000	−1.0	+3.4	−2.4	+0.6	−10.6	+3.9	3.7	+3.4	−8.5	+2.7
4,000	−7.4	+2.2	−7.1	+1.5	−17.6	+2.2	−0.1	+4.4	−15.2	+2.0
5,000					−25.2	+0.4				

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during February, 1930*—Continued

RELATIVE HUMIDITY (%)

Altitude m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Meters										
Surface	70	+1	66	−3	83	+2	78	+4	76	−2
500	65	−1	56	−8	82	+2	75	+7	75	−3
1,000	57	0	50	−10	66	−4	57	−1	69	−1
1,500	49	−2	46	−10	58	−4	47	−4	59	−3
2,000	47	+1	45	−9	59	0	37	−9	52	−4
2,500	50	+6	43	−9	63	+4	28	−16	50	−4
3,000	49	+6	40	−9	64	+6	28	−14	55	0
4,000	57	+16	32	−14	70	+15	14	−23	46	−11
5,000					76	+18				

VAPOR PRESSURE (*mb.*)

Surface	9.22	+2.98	7.93	−0.06	4.33	+1.74	12.47	+2.98	6.41	+1.89
500	8.32	+2.84	7.06	−0.01	4.21	+1.67	11.16	+3.02	5.71	+1.78
1,000	6.83	+2.44	5.58	−0.47	3.49	+1.17	7.95	+1.35	4.74	+1.52
1,500	5.18	+1.60	4.28	−0.61	2.91	+0.84	5.61	+0.46	3.67	+1.13
2,000	4.11	+1.29	3.40	−0.46	2.42	+0.69	3.53	−0.48	2.53	+0.52
2,500	3.58	+1.26	2.52	−0.49	2.02	+0.60	2.21	−1.03	1.94	+0.28
3,000	2.85	+0.96	1.74	−0.54	1.59	+0.48	1.69	−0.99	1.78	+0.44
4,000	1.99	+0.68	0.48	−0.70	0.68	+0.01	0.19	−1.57	1.38	+0.55
5,000					0.34	−0.04				

TABLE 3.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during February, 1930*

Altitude (meters) m. s. l.	Broken Arrow, Okla. (233 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,868 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (65 meters)		Key West, Fla. (11 meters)		Los Angeles, Calif. (40 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°	
Surface	S 6 W	3.0	S 13 W	1.4	N 84 W	6.2	S 23 W	0.5	N 69 W	3.0	S 14 E	0.5	S 53 W	2.6	N 12 E	1.2	N 75 E	2.5	N 81 W	2.0
500	S 17 W	7.2	S 53 W	3.1	----------	----	S 77 W	3.0	N 68 W	4.4	S 29 W	5.8	----------	----	S 40 E	1.3	S 85 E	6.0	N 71 E	0.7
1,000	S 45 W	7.2	N 58 W	6.1	----------	----	S 83 W	4.3	N 55 W	10.0	S 45 W	4.9	S 69 W	7.5	S 26 W	1.8	S 70 E	5.4	N 2 E	0.4
1,500	S 63 W	6.6	N 59 W	9.7	----------	----	S 88 W	6.8	N 65 W	10.9	S 72 W	1.5	W	10.2	S 79 W	3.5	S 56 E	3.0	N 59 W	1.6
2,000	S 81 W	7.9	N 46 W	12.1	N 83 W	9.7	N 86 W	8.5	N 63 W	12.5	S 81 W	2.2	N 82 W	12.3	N 83 W	4.5	S 23 E	1.5	N 41 W	2.5
2,500	N 86 W	9.5	N 51 W	11.6	N 74 W	13.9	W	10.5	N 70 W	13.8	N 50 W	3.1	N 78 W	12.7	N 78 W	5.2	S 27 W	1.9	N 46 W	3.4
3,000	S 87 W	8.9	N 51 W	12.7	N 67 W	13.6	N 84 W	11.4	N 67 W	14.1	N 63 W	5.4	N 83 W	10.4	N 77 W	8.1	N	0.6	N 37 W	4.5
4,000	----------	----	N 67 W	12.2	N 59 W	7.1	N 75 W	11.6	N 60 W	16.6	N 87 W	11.6	S 87 W	6.6	N 80 W	10.3	N 72 W	5.2	N 50 W	6.8
5,000	----------	----	----------	----	----------	----	N 80 W	13.6	----------	----	----------	----	----------	----	N 86 W	11.6	N 74 W	8.0	----------	----

Altitude (meters) m. s. l.	Medford, Oreg. (446 meters)		Memphis, Tenn. (145 meters)		New Orleans, La. (25 meters)		Omaha, Nebr. (313 meters)		Royal Center, Ind. (225 meters)		Salt Lake City, Utah (1,280 meters)		San Francisco, Calif. (60 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (67 meters)		Washington, D. C. (34 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°	
Surface	S 33 E	0.2	S 13 W	1.7	N 54 E	1.2	S 48 W	0.3	S 59 W	2.0	S 27 E	2.5	S 33 E	1.3	N 39 E	0.6	S 24 E	1.6	N 63 W	0.7
500	S 55 W	0.4	S 59 W	5.7	S 68 E	2.9	S 75 W	3.5	S 65 W	6.6	----------	----	N 52 W	2.0	N 60 E	2.4	S 9 W	6.0	N 86 W	6.3
1,000	S 13 W	2.6	S 82 W	5.0	S 9 E	1.2	N 81 W	7.7	N 86 W	9.8	----------	----	N 24 W	4.6	N 35 W	2.2	S 9 W	7.0	N 72 W	8.5
1,500	S 47 W	5.6	N 81 W	5.5	S 51 W	2.9	N 75 W	9.0	N 80 W	9.2	S 7 E	4.9	N 28 W	4.6	N 76 W	4.6	S 29 W	7.6	N 80 W	11.0
2,000	S 61 W	7.2	N 78 W	5.4	S 85 W	3.8	N 75 W	10.2	S 86 W	11.8	S 24 W	4.2	N 34 W	4.4	----------	----	S 78 W	3.0	N 76 W	12.1
2,500	S 73 W	9.7	N 88 W	7.3	S 86 W	5.3	N 88 W	11.1	----------	----	S 79 W	4.4	N 56 W	4.0	----------	----	N 84 W	3.2	N 80 W	11.9
3,000	S 86 W	10.0	S 78 W	6.2	S 85 W	5.3	N 89 W	12.7	----------	----	N 86 W	6.8	N 68 W	4.9	----------	----	N 70 W	6.8	N 85 W	13.9
4,000	N 68 W	9.0	----------	----	----------	----	----------	----	----------	----	N 86 W	8.3	----------	----	----------	----	----------	----	----------	----

TABLE 2.—*Free air data determined at naval air stations during February 1930*

Altitude (meters) m. s. l.	Temperature (° C.)			Relative humidity (%)		
	Pensacola, Fla.	San Diego, Calif.	Washington, D. C.	Pensacola, Fla.	San Diego, Calif.	Washington, D. C.
Surface	11.8	14.8	3.3	84	72	73
500	12.5	14.1	3.4	64	61	66
1,000	10.4	13.8	2.8	64	50	60
2,000	5.6	9.3	−1.5	58	35	55
3,000	0.9	5.2	−5.8	44	24	47
4,000			−13.1			53

TABLE 4.—*Observations by means of kites, captive and limited-height sounding balloons during February, 1930*

	Broken Arrow, Okla.	Due West, S. C.	Ellendale, N. Dak.	Grosbeck, Tex.	Royal Center, Ind.
Mean altitudes (meters) m. s. l., reached during month	2,808	2,617	2,957	2,418	2,611
Maximum altitude (meters) m. s. l., reached and date	[1] 4,439	[2] 4,359	[3] 5,107	[4] 4,172	[5] 4,531
Number of flights made	32	30	28	26	29
Number of days on which flights were made	27	28	28	22	27

[1] 17th. [2] 22d. [3] 3d. [4] 8th. [5] 21st.

In addition to the above there were approximately 125 pilot balloon observations made daily at 53 Weather Bureau stations in the United States.

WEATHER IN THE UNITED STATES

THE WEATHER ELEMENTS

By P. C. DAY

GENERAL SUMMARY

The outstanding feature of the weather of the month was the remarkable warmth that prevailed over most portions of the country from about the 18th to 25th. Springlike weather prevailed to an unusual extent on a number of days during this period, and temperatures above any previously recorded in February were reported by some stations on several successive dates, a most unusual occurrence; also the extremes were in many cases a number of degrees higher than previously recorded.

Aside from the temperature abnormalities referred to, the weather elements were mainly not unusual.

PRESSURE AND WINDS

At the beginning of February high pressure existed in the central Plateau region, but without attendant cold; in fact warmer weather prevailed over most districts, a condition that may be expected with the entrance of an anticyclone into the United States at such a low latitude, and moderate temperatures continued for several days, save that a movement of high pressure southward from Hudson Bay toward New England brought sharp changes to cooler by the 4th in New England and the adjoining Maritime Provinces of Canada. At the same time low barometric pressure prevailed along the northern border with local precipitation at many points. By the 4th low barometric pressure had moved to the lower Mississippi Valley, and heavy rains had overspread near-by areas. This storm moved off the southern New England coast by the following morning, and was quickly followed by another low-pressure area moving into the Lake region, with attending light snow in the northern Plains and to the eastward. In the meantime the high pressure over the Plateau had remained nearly stationary, attended by generally fair conditions, and much colder weather had overspread New England and near-by areas in both the United States and Canada, temperatures of 50° or more below zero being reported from the interior of the Province of Quebec, though this cold was quickly followed by decided warmth over the same area.

By the morning of the 9th the anticyclone that had remained over the Pleateau had been reinforced by an area of high pressure from the Pacific Northwest and was central over the northern Rocky Mountain region, attended by sharp changes to lower temperatures in that region, but there was considerable warming to the eastward with falling pressure and some snow over the Lake region, the cyclonic conditions moving into the St. Lawrence Valley by the 10th; and light snow continued over portions of the Great Lakes, turning to light rain over small areas to the southward.

On the 11th there was considerable warming up from the central Rocky Mountains northeastward over the Dakotas and near-by areas in Canada, but lower temperatures prevailed in most northern districts from the Great Lakes eastward. By the following day there were three important temperature changes progressing along the northern border; the warm area of the 11th had moved eastward to the Great Lakes, extending southward to the northern part of the Gulf States, while the cold area to the eastward had moved to New England, and a new cold wave had developed in the upper Missouri Valley and to the northward, where changes from 20° to 40° colder were noted. Similar conditions existed during the 13th, the several areas having moved eastward in their respective orders, though the cold in the Northwest extended its area materially, while the similar area of cold over the Northeast had practically passed into the North Atlantic. During this period considerable precipitation occurred along the northern border from the Pacific eastward to near the Atlantic coast, with some snow at scattered points in the northern portions. On the 14th precipitation continued at scattered points somewhat further south than on the previous day, and it became rather general over the eastern section from the Gulf States northeastward to New England, with more or less snow, particularly from the Dakotas eastward into New England, where, near the coast, the precipitation became comparatively heavy.

There was scattered precipitation in east-central districts on the 15th, mostly snow, which continued over the coast districts on the following day, the snow turning to rain in the central and southern sections. This precipitation area was followed on the 16th by much warmer weather over the northern districts between the Mississippi River and the Rocky Mountains, and this warmth gradually moved toward the Atlantic coast during the following two days.

By the 19th anticyclonic conditions had become established over most southern districts, and high temperatures prevailed in practically all of the country, continuing with some local interruptions into the middle of the third decade, when precipitation set in over many central districts followed by changes to cooler over the interior portions, the lower temperatures moving eastward in the wake of the precipitation area that was advancing from the central valleys on the 26th and 27th. By the morning of the 27th low barometric pressure had moved into the central Plateau region attended by local snows at the higher elevations, and during the following day advanced

slowly into the lower Missouri Valley, where snow changed to rain locally, and at the end of the month the storm was advancing toward the upper Lakes, snow again falling in the districts to northward of the center, and rain continuing in the middle Mississippi and portions of the Ohio Valleys. At the same time precipitation had set in over the Middle Gulf States.

The average pressure for the month was usually less than normal over the central and northern districts from the Lake region and Mississippi Valley westward, save in the far Southwest, and was above normal from the Gulf States northeastward to New England and eastern Canada. Compared with the averages for the preceding month, pressures were lower over practically all portions, and decidedly lower over the central and northern districts and in the adjacent portions of the Canadian Northwest.

The winds of the month were unimportant in the matter of damage, and occurred at infrequent intervals; and as a rule they were confined to limited areas.

The distribution of the averages of pressure for the month as a whole, the departures from the normal, and the changes in pressure from January to February are shown on the usual charts, while the important facts in connection with wind and other storms appear, as is customary, at the end of this section.

TEMPERATURE

Unlike the preceding January, which was extremely cold over many of the western parts, February experienced much warm and springlike weather, particularly during the last day or two of the second decade and the early part of the last decade. Temperatures in excess of any that had previously been recorded in February were reported at numerous points in the central-western area.

The first two days of February were mainly warmer than normal, while the 3d was moderately cool over the far West, and the 4th was cool over the Northeastern States, and in portions of the Great Plains and Rocky Mountain regions.

For the week ended February 11, the mean temperatures were above normal over all parts of the country, save a small area in Colorado, and in parts of the Northeast. The week ended February 18 was likewise warmer than normal in all midwestern and far western districts, but it was moderately cool over the eastern third. The week ended February 25 was one of abnormal warmth, the weather partaking more of that associated with mid spring than of midwinter. In some of the northern and central sections this period was the warmest ever associated with February, the weekly averages ranging up to nearly 30° above the normal for that period of the month; the individual daily values were in a number of instances decidedly higher than had ever before been registered in February, while in some cases the monthly means, as a result of these unusual temperatures, were the highest ever observed in the month. The last three days of the month were cooler than normal, save in some few localities.

The maximum temperatures occurred mainly during the heated period of the first half of the last decade, principally from the 23d to 25th, though in the more western districts they occurred mainly a few days earlier.

The lowest temperatures were reported from a few of the more southern districts on the 1st, but in most other districts the lowest temperatures were recorded about the 15th or 16th, though in a few western localities they were delayed until toward the end of the month.

As stated elsewhere, only one small area in western Colorado had averages of temperature below the normal. In all other districts the average temperatures for the month were above the normal, and in numerous large areas over the central and northwestern parts they ranged from 10° to 15° or more above.

PRECIPITATION

As is apt to be the case in a month so unexpectedly mild, precipitation was mainly less than normal. This was especially true of the eastern, southern, and central sections. The largest area with precipitation greater than normal included most northern counties of Michigan and Wisconsin, and practically all of Minnesota and the Dakotas. Much of Washington likewise had more than normal precipitation, which was fortunate in view of the shortage there during January.

The southern part of the Florida Peninsula and an area including much of Oklahoma and Arkansas with parts of eastern Texas and northern Louisiana were other districts where amounts moderately greater than normal were received.

Altogether, 13 States of the 48 had more precipitation than their February averages, but of these only Minnesota, North Dakota, and Washington received more than 120 per cent of the normal.

The largest amount reported from any single station was slightly more than 30 inches, measured at a point in northwestern Washington.

Precipitation was wholly absent or was negligible over large portions of New Mexico and Texas. Most parts of the Southwest, including California and Nevada, received much less than normal, likewise nearly all the lower Missouri Valley. In the eastern half of the country the shortage was marked from Mississippi and Alabama northeastward through the Appalachian region to Maryland, also to eastward from the mountains to the coast in districts from Georgia to southern New Jersey. Likewise in northeastern New York and central and northern New England, there was nearly everywhere a considerable shortage.

SNOWFALL

In almost every portion of the country the snowfall was less than the averages found from previous Februarys. Particularly marked was the shortage from the middle Plains eastward over the central valleys to the Middle Atlantic coast, where much snow is looked for and scarcely any occurred. To southward, the entire area of the important cotton States had no snow, save a few had small amounts, mainly in mountainous portions. The southern limit of February's snowfall is thus found considerably farther north than usual, in marked contrast with the location of the January limit, which was far to the southward of the average position.

In the States near the middle of the Canadian boundary the month's snowfall was usually somewhat greater than normal. Here, and in most of the far West besides, the chief snowfalls came during the last decade of the month. The only important snowfall from the middle Plains eastward, however, occurred about the middle of the month, just before the chief cold period.

The stored snow in the elevated portions of the far West was usually of disappointing quantity when February ended. In New Mexico and the extreme Northwest this was especially true, remarkably little remaining at that time. However, the middle and northern Rocky

Mountain region and the eastern parts of the middle Plateau were indicated in some districts to have sufficient snow to promise an average water supply, though the outlook as a whole for a good late water flow was discouraging.

RELATIVE HUMIDITY

The relative amount of moisture in the atmosphere was well below the normal as deduced from previous records over important areas, the deficiencies being large in many southern districts, where they ranged up to as much as 25 per cent. They were also less than normal, but to a slightly less degree, in portions of the Great Plains, Rocky Mountain, and Plateau districts, though in these areas there were small localities having values somewhat above normal, and similar conditions existed over the Pacific Coast States, along the middle Gulf coast, over portions of New England and in the upper Lake region.

SEVERE LOCAL STORMS, FEBRUARY, 1930

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Berrien County, Ga.	4					Wind	Trees blown down; old barns unroofed	Official, U. S. Weather Bureau.
Mint Hill, N. C.	4	7.30 p. m.	200		$2,000	Tornadic wind	Damage mainly to small houses, barns, and timber. Path 4 miles long.	Do.
Toole County, Mont.	10					High wind	Character of damage not reported	Do.
Central City, Ind. (near)	12				10,000	Electrical and wind.	Considerable damage to power plant at coal mine. Power lines to towns in vicinity damaged.	Do.
Cascade County, Mont.	18					Destructive wind.	Many thousands of dollars damage in and near Browning.	Do.
Springfield, Ill., and vicinity.	23–24					Severe thunderstorm.	Basements flooded; street light affected; 3 barns burned.	Do.
Indianapolis and Richmond, Ind.	24					Hail and thunderstorm.	Much glass in greenhouses broken; some roofs damaged.	Do.
Roseville, Ohio (near)	24	5:30 p. m.	100–200		150,000	Severe thunderstorm and tornadic wind.	Heavy property loss; 4 persons injured; 300 people suffered temporary loss of work. Path about 1 mile long.	Do.
San Francisco, Calif.	24					Thunderstorm and wind.	Some damage by lightning	Do.
Cairo, Ill.	25	P. m.			1,300	do	Pumping plant damaged	Do.
San Jose, Calif.	26	4 p. m.				Hail and wind	Street car service interrupted, some roofs damaged and trees broken.	Do.

RIVERS AND FLOODS

By R. E. SPENCER

Details of overflow and damage caused by the flood in the Wabash system in January, 1930, which had not been received in time for inclusion in the REVIEW for that month, are given below. The quotation, taken from the report of Mr. J. H. Armington, official in charge of the Indianapolis, Ind., office of the Weather Bureau, includes also some further comment on precipitation and stages, with particular reference to comparative features of the 1913 and 1930 floods:

The stages reached in the great flood of March, 1913, except at Vincennes on the Wabash and at Decker on the White, considerably exceeded those of January, 1930. At most points on the White the crests of the January flood were exceeded also by those of February, 1916; and the same was the case at a few points on the middle Wabash, particularly at Terre Haute, although the difference at Terre Haute was but 0.4 foot. Therefore, as the severity of flooding was not so great above the junction of the forks of the White and above the middle-upper Wabash, estimates on areas inundated are confined to the Wabash Valley from Tippecanoe County downstream to the mouth.

Along that stretch of the river a total of approximately 684 square miles were overflowed, 293 square miles being in Illinois and 391 square miles in Indiana. The most extensive and most severe flooding, however, was from Knox County southward on the Indiana side and from Lawrence County southward on the Illinois side of the river. Lawrence County heads the list with 121 square miles of flooded territory, while Gibson and Knox Counties are second and third, with 91 and 87 square miles, respectively, and Posey County is fourth, with 86 square miles.

Had it not been for the breaking of levees from Vincennes upstream past Terre Haute and for the further stage diminution caused by the opening of levee gates above Terre Haute and by the severe cold which overspread the entire region just as the water was approaching its highest points, the stages reached above Vincennes would undoubtedly have been considerably higher than they were. As it was, the crests were not only reduced, but their occurrence was considerably hastened in point of time; so that, from source to mouth, they occurred within a period of about three days, whereas ordinarily the flood wave requires somewhat more than a week to run its course.

Even without the reduction thus produced, however, it is practically certain that the crests of the January flood would not have been as high as those of the flood of March, 1913, unless the building and changing of levees since that time has materially altered flood heights. This conclusion is based on the fact that the average rainfall over the entire Wabash Valley in the flood of March, 1913, was more than 1 inch greater in its period of five days than was the average rainfall over the same region in the flood of January, 1930, over its period of eight days. Even the somewhat higher initial stages which at most places preceded the period of rainfall in 1930 would not balance the greater amount of rainfall and shorter period in 1913. It may be noted in passing that careful study of the 1913 situation at Vincennes has placed the crest of the flood in that year at 28 feet at least had it not been for wide breaks in the levees of both Wabash and tributary streams. The same statements are applicable to the main stream of White River from the junction of the forks to its mouth.

Damage and loss caused by flooding.—Data on damage and loss by flooding are given below for the Wabash and the White Valleys separately:

Losses and damage in the Wabash Valley proper:

Item No. 1, tangible property—	
Levees	$75,930
Public utilities	4,000
Industries	111,463
Railroads	240,301
Cities and communities	34,600
Fences	510,850
Roads and bridges	113,000
Total	1,090,144
Item No. 2, farm property—	
(*a*) Matured crops	3,818,550
(*b*) Prospective crops	463,530
(*c*) Equipment, livestock, etc	601,110
Total	4,883,190

Losses and damage in the Wabash Valley proper—Con.	
Item No. 3, suspension of business	$167,278
Grand total, Wabash Valley	6,140,612
Item No. 4, property saved by flood warnings, value of	482,500
Losses and damage in White River Valley:	
Item No. 1, tangible property	349,008
Item No. 2, farm property—	
(a) Matured crops	290,925
(b) Prospective crops	27,960
(c) Equipment, livestock, etc	20,300
Total	339,185
Item No. 3, suspension of business	33,500
Grand total, White River Valley	721,693
Item No. 4, property saved by flood warnings, value of	81,850

The grand total of all losses reported in the combined Wabash-White system in the January, 1930, flood is therefore $6,862,305, and the total value of property saved as a result of flood warnings issued is $564,350.

Other reports received too late for inclusion in the January REVIEW describe the floods of the Illinois, Meramec, Black, and upper St. Francis Rivers in that month as generally moderate. On the Meramec a loss of about $150 resulted from suspension of business. In the vicinity of Poplar Bluff, Mo., on the Black River, damage to the extent of $26,000 occurred, distributed as follows: Matured crops, $5,000; prospective crops, $10,000; livestock and other movable property, $1,000; suspension of business, $10,000. At Fisk, Mo., on the St. Francis River, about $5,500 was lost owing to suspension of business.

Report on the Tallahatchie River flood of and following January, which was to have appeared in this issue of the REVIEW, is again delayed for the reason that the flood had not finally subsided at the end of February.

Floods during February were generally of little consequence.

In the Atlantic drainage no damage occurred.

The most important result of the moderate thaw and ice rises in the Great Lakes drainage was a loss of $1,165 at Flint, Mich., from flooded basements. A saving of $500 was affected through Weather Bureau warnings along the Saginaw River.

In the Ohio drainage two inconsequential ice gorges formed in the Allegheny River—one at Kittanning and the other at Dam No. 8; about $1,000 was lost because of business suspension in Pittsburgh; and some inconvenience was experienced in dam operation during the ice movement in the Ohio. The rises in the interior rivers of Ohio were of no special importance, nor was that in the Wabash-White system, where practically all possible damage had been done by the greater flood of January.

Reports on the rises in the Illinois, Meramec, and St. Francis Rivers, though so far incomplete, indicate that these floods were of little or no consequence, as were also the remainder of lower Mississippi drainage rises, except those in the Tallahatchie and Sulphur Rivers. Discussion of the Tallahatchie flood, which continued into March, will appear later. Along the Sulphur River highways were damaged to the extent of $1,500, $500 worth of livestock was drowned, $2,500 loss resulted from suspension of business, value of Weather Bureau flood warnings estimated at $11,000.

The Trinity flood of Texas was unimportant.

[All dates in February unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
	Feet			*Feet*	
Roanoke: Weldon, N. C	30	6	7	31.6	7
Nuse: Smithfield, N. C	14	6	8	14.5	6-7
Cape Fear: Elizabethtown, N. C	22	6	8	24.8	7
Peedee: Mars Bluff, S. C	17	6	12	19.0	9
Santee:					
Rimini, S. C	12	[1]	13	21.0	Oct. 7, 1929
		22	[2]	13.3	23
Ferguson, S. C	12	[1]	18	13.4	11-12
		21	[2]	12.6	24
Altamaha:					
Charlotte, Ga	15	4	12	16.8	7-8
Everett City, Ga	10	3	18	11.0	10-12
Ocmulgee: Abbeville, Ga	11	4	9	12.3	6
EAST GULF DRAINAGE					
West Pearl: Pearl River, La	13	[1]	16	14.9	3-4
GREAT LAKES DRAINAGE					
St. Joseph: Montpelier, Ohio	10	21	21	10.9	21
		24	26	10.7	26
Saginaw: Saginaw, Mich	19	25	[2]	20.7	27
Flint: Flint, Mich	11	23	[2]	12.8	25
Pine: Alma, Mich	7	24	27	9.2	25
Cass: Vassar, Mich	14	26	26	15.0	26
Grand:					
Eaton Rapids, Mich	5	21	[2]	5.4	22
Grand Ledge, Mich	7	21	28	8.2	24
Lowell, Mich	15	27	27	15.1	27
Grand Rapids, Mich	11	23	[2]	13.3	28
Red Cedar:					
Williamston, Mich	6	20	24	7.0	21
East Lansing, Mich	8	21	22	8.9	22
MISSISSIPPI DRAINAGE					
Allegheny:					
Lock 5, Freeport, Pa	24	25	27	27.2	27
Lock 4, Natrona, Pa	24	27	27	24.8	27
Kiskiminetas: Saltsburg, Pa	8	25	25	8.2	25
Tuscarawas:					
Newcomerstown, Ohio	10	28	28	11.3	28
Coshocton, Ohio	8	26	28	12.0	27
Walhonding: Walhonding, Ohio	8	25	27	11.2	26
Scioto:					
Bellpoint, Ohio	9	26	27	9.4	26
Circleville, Ohio	10	26	28	13.8	27
Chillicothe, Ohio	16	27	28	19.1	28
Olentangy: Delaware, Ohio	9	26	26	11.7	26
Green:					
Munfordville, Ky	21	6	6	21.4	6
Lock 4, Woodbury, Ky	33	6	7	33.5	7
Wabash:					
Lafayette, Ind	13	26	28	15.4	27
Covington, Ind	16	[1] 6	10	17.0	8
		26	[2]		
Terre Haute, Ind	16	28	[2]		
Mount Carmel, Ill	16	[1] 15	17	16.3	16
		28	[2]		
Tippecanoe: Norway, Ind	6	23	[2]	6.5	24
White, East Fork: Seymour, Ind	10	13	13	10.5	13
White, West Fork:					
Anderson, Ind	12	26	27	12.8	27
Elliston, Ind	19	27	[2]		
Edwardsport, Ind	15	[1] 14	16	16.6	15
		27	[2]		
Mississippi: Vicksburg, Miss	45	[1]	6	45.7	3
Illinois:					
Morris, Ill	13	25	28	14.4	26
Peru, Ill	14	[1]	[2]	18.4	27
Henry, Ill	10	25	[2]		
Peoria, Ill	18	27	[2]		
Havana, Ill	14	[1]	[2]		
Beardstown, Ill	14	[1]	3	14.3	Jan. 31-Feb. 1
		9	[2]		
Pearl, Ill	12	[1]	10	13.6	Jan. 29-30
					Feb. 7
		14	15	12.2	14-15
		23	[2]		
Meramec:					
Steelville, Mo	12	26	26	12.9	26
Pacific, Mo	11	26	[2]	14.9	28
Valley Park, Mo	14	27	[2]	15.6	27
St. Francis:					
Chaonia, Mo	22	[1] 5	6	23.4	6
		27	27	22.7	27
Fisk, Mo	20	[1] 5	9	23.2	7
		28	[2]		
St. Francis, Ark	18	5	15	20.4	10
Marked Tree, Ark	17	[1]	22	18.7	4-6
Osage: Osceola, Mo	20	7	11	20.9	9
Arkansas: Yancopin, Ark	29	[1]	28	35.0	Jan. 27-30
Petit Jean: Danville, Ark	20	5	7	21.9	6
White:					
Georgetown, Ark	22	6	15	22.8	11
DeValls Bluff, Ark	24	13	13	24.0	13

[1] Continued from last month.
[2] Continued at end of month.

[All dates in February unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI DRAINAGE—continued					
Black:	Feet			Feet	
Corning, Ark.	11	(1)	1	14.8	Jan. 20
		4	19	13.0	7-8
		28	28	11.1	28
Black Rock, Ark.	14	(1)	1	23.6	Jan. 15
		4	15	18.5	6
Cache: Patterson, Ark.	9	(1)	18	11.5	Jan. 15
Tallahatchie: Swan Lake, Miss.	25	(1)	(2)	31.9	Jan. 27-29
Sulphur:					
Ringo Crossing, Tex.	20	4	5	21.8	5
Finley, Tex.	24	7	11	26.3	8
Ouachita:					
Arkadelphia, Ark.	12	4	6	18.9	5
Camden, Ark.	30	7	12	34.8	9
WEST GULF DRAINAGE					
Trinity:					
Trinidad, Tex.	28	6	6	28.8	6
Liberty, Tex.	25	7	10	25.8	8-9

[1] Continued from last month. [2] Continued at end of month.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, FEBRUARY, 1930

By J. B. KINCER

General summary.—The weather for February, 1930, was in marked contrast to January, for temperatures were decidedly above normal, particularly in those sections that had the greatest minus departures in January. Some areas showed a range of about 25° in the departures from normal for the two months, varying from −12° in January to +16° or more in February.

The mild weather during the first decade was favorable for outside operations, but the soil remained too wet to work in many areas, although abundant sunshine aided in drying. The main wheat sections were mostly bare of snow, with some complaints of heaving in the Ohio Valley, while parts of the southwestern belt continued dry. Winter truck crops made satisfactory advance in the South and the weather generally favored livestock interests in the great western grazing areas. Plowing was largely prevented in the Corn Belt due to wet soil, but seasonal operations made fairly good advance in the Cotton Belt.

During the second decade there was a rather severe cold wave, but the period was fairly favorable for agricultural interests. Wheat fields were partially protected in the main producing sections, but toward the close of the decade they were again mostly bare; there were some further complaints of freezing and thawing in interior valleys. There were no material damaging low temperatures in the South and winter truck crops made fairly good advance, except for too much moisture on the lowlands of Florida. Livestock were again favored; plowing was rather inactive in the Corn Belt, but much work was accomplished in the Cotton Belt.

During the last decade the continued mild weather caused rapid advance of vegetation generally and especially to early fruit trees, with decided swelling of buds noted north to the central valley areas and some early plum bloom showing in the lower Ohio Valley. There was much apprehension felt at the close of the month from possible frost injury. The period was generally ideal for outside operations and much spring work was accomplished. Grass and wheat fields showed a decided greening to central valley sections and the weather conditions were favorable in the western range country. The soil continued too wet in many parts of the Corn Belt for active preparation of the soil, but in the Cotton Belt much plowing was accomplished.

Small grains.—The mild weather during the first decade caused the snow to disappear rapidly and large areas were bare. There were no indications of serious injury from the January freezes, but reports of unfavorable freezing and thawing came from the Ohio Valley, although no material damage was indicated. The remaining oat crop made fair advance in the South, while the soil was too wet for spring seeding. There was further reduction of the snow cover in the Northwest during the second decade, while freezing and thawing conditions continued in the Ohio Valley, although damage was not extensive. Winter wheat was mostly satisfactory and precipitation was favorable in the Pacific Northwest. Winter cereals improved in the South and at the close of the period spring oats were being sown north to Oklahoma and Arkansas.

The abnormally warm weather during the last decade caused a complete disappearance of the few patches of snow remaining in the Winter Wheat Belt and fields were greening north to Iowa and New York. Condition of the crop appeared satisfactory generally, except for some complaints in the Ohio Valley, particularly to the late-planted. Some spring wheat was seeded and preparations for seeding spring oats advanced rapidly with a little put in locally north to Kansas.

Miscellaneous crops.—The abnormally warm weather during the month was very favorable for livestock interests; shed lambing especially was benefited. The disappearance of the snow cover opened much range and permitted active grazing, with a consequent saving of feed. There were reports of continued dryness in the Southwest, especially in eastern New Mexico and western Texas, but in most other of the great western grazing sections range and water conditions were satisfactory.

Those truck crops which survived the freezes in January continued in satisfactory condition and spring planting progressed well throughout the month, except on some wet lowlands in Florida. At the close of the month planting potatoes and early garden crops had advanced north to Maryland and in the Middle West to Missouri. The abnormally warm weather caused fruit buds to advance prematurely and at the close of the month swelling was reported north to southern Wisconsin and color showing in some early varieties to southern Indiana. Peaches and plums were in full bloom in parts of the Gulf section. Citrus groves did well in Florida and California.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

NORTH ATLANTIC OCEAN

By F. G. TINGLEY

The month of February brought a cessation in the severe conditions of the eastern North Atlantic which had persisted with little interruption since the latter part of November. At Lerwick (Shetland Islands), where low pressure had been continuous and marked for a period of four months, there was a pronounced change to high pressure. The mean monthly pressure values at Lerwick for the several months (with departures from normal in parentheses) are as follows: October, 29.47 (−0.32); November, 29.44 (−0.26); December, 29.28 (−0.44); January, 29.37 (−0.33); February, 30.19 (+0.47). In connection with this rise in pressure attention is invited to a correspondingly marked fall in pressure over the Gulf of Alaska and neighboring regions referred to in the accompanying review of the weather of the North Pacific Ocean.

The general distribution of pressure in the North Atlantic area for February is shown in the following table:

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, 8 a. m. (seventy-fifth meridian), North Atlantic Ocean, February, 1930*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.45	(1)	29.96	20th	28.46	28th.
Belle Isle, Newfoundland	29.75	[2] 0.00	30.38	19th	28.68	9th.
Halifax, Nova Scotia	30.00	[2] +0.02	30.42	18th	29.56	5th.
Nantucket	30.05	[2] +0.05	30.54	17th	29.40	5th.
Hatteras	30.16	[2] +0.05	30.48	17th	29.60	5th.
Key West	30.08	[2] −0.02	30.22	9th	29.86	7th.
New Orleans	30.14	[2] +0.01	30.38	18th	29.78	4th.
Cape Gracias, Nicaragua	29.94	[2] −0.05	29.98	1st [3]	29.88	14th.[4]
Turks Island	30.11	[2] −0.03	30.22	27th	30.02	13th.[4]
Bermuda	30.11	[2] −0.05	30.32	10th	29.70	8th.
Horta, Azores	30.16	[2] +0.03	30.38	17th	29.90	8th.
Lerwick, Shetland Islands	30.19	[2] +0.47	30.66	8th	29.43	1st.
Valencia, Ireland	30.13	[2] +0.23	30.69	10th	28.84	1st.
London	30.09	[2] +0.09	30.65	9th	28.82	1st.

[1] No normal available.
[2] From normals shown on Hydrographic Office pilot charts, based on observations at Greenwich mean noon, or 7 a. m., seventy-fifth meridian time.
[3] From normals based on 8 a. m. observations.
[4] And on other date or dates.

The month opened with a deep and widespread depression over the eastern part of the ocean, giving rise to stormy weather on the French, Spanish, and Portuguese coasts. This depression advanced slowly eastward and southeastward and on the 7th was over southern Europe. It was followed by high pressure that advanced from the direction of Iceland and by the 8th anticyclonic conditions were established over the British Isles and adjacent waters. With some interruptions, high pressure prevailed over this general area, as well as western Europe, until the close of the month.

From the 2d to the 7th a series of disturbances caused almost continuous gales along the steamer lanes. The principal area of these gales shifted to the westward day by day until the latter date when it was situated just east of Newfoundland.

Charts VIII–XI portray conditions over the ocean for the 1st, 5th, 6th, and 7th, and show the westward recession of the gale area during the opening week of the month.

On the morning of the 8th quiet conditions prevailed generally, but in the course of the day there was a redevelopment in the neighborhood of Newfoundland and gales were reported in various parts of the area on both that day and the 9th. Two vessels, the Belgian steamship *Henri Jaspar* and the American steamship *Bellepline*, reported winds of hurricane force.

Associated with this reversal of pressure conditions there was a gradual shifting of stormy conditions to the central and western parts of the ocean, where they persisted until the middle of the month.

From about the 17th to 24th a period of quiet weather marked the entire ocean. On the latter date a small but vigorous disturbance developed to the westward of the British Isles, whence it moved southeastward and dissipated over Spain on the 28th. This depression gave rise to strong gales over portions of the eastern steamer lanes and in places to winds of hurricane force.

From the 24th to the 27th there was a general and widespread fall in pressure over the western part of the ocean and on the latter date readings below 29 inches were recorded by vessels to the east of Newfoundland. From these waters a trough of low pressure extended southwestward to Bermuda and moderate to strong gales were experienced in various parts of this extensive area.

The close of the month found a troughlike depression in mid-ocean, extending from Greenland (Julianehaab 28.46 inches on the 28th) to latitude 35° N., where the steamship *Ossining* on the same date reported a pressure of 29.47 inches. From reports at hand it would appear, however, that the depression had lost energy since the preceding day.

Viewing the month as a whole, the weather should probably be characterized as less stormy than the preceding months of December and January. However, it will be noted from the accompanying table of gales that many vessels experienced very heavy weather. Pressure extremes in the Northern Hemisphere in February were not as pronounced as in the other months named and it would appear that the ocean storms were likewise less intense than those that made the preceding months notable in the annals of winter gales on the North Atlantic.

Less than the normal February amount of fog was encountered along the steamer lanes and its occurrence was confined to one or two days as reported east of the fortieth meridian. It was observed on about six days in the neighborhood of the Grand Banks and on about seven days at points along the American coast between Sydney and Norfolk. It also occurred on about seven days along the upper Gulf coast between Florida and eastern Texas.

OCEAN GALES AND STORMS, FEBRUARY, 1930

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
North Atlantic Ocean			° ′	° ′				*Inches*					
Milwaukee, Ger. M. S.	Bishops Rock	New York	47 05 N	39 00 W	Feb. 1	9 p., 1	Feb. 2	29.05	SE.	WSW, 12	W.	W, 12	SE-SW-W.
Vermont, Fr. S. S.	Bordeaux	Gaudeloupe	44 46 N	4 32 W	1	—, 1	2	28.77		WSW, —.	SW.	—, 11	SW-WSW.
Ossining, Am. S. S.	Baltimore	Algiers	37 10 N	15 34 W	1	10 a, 1	1	29.92	NW.	NW, 10	NW.	NW, 10	NW.
West Eldara, Am. S. S.	New York	Antwerp	47 30 N	34 17 W	1	2 a., 2	3	29.16	WSW.	WSW, 9	WNW.	W, 11	WSW-W.
Emanuel Nobel, Belg. S. S.	Manchester	Marcus Hook	50 26 N	23 27 W	2	—, 2	4	28.90	SW.	SW, 11	Var.	SW, 11	SW-W-WNW.
Sneaton, Br. S. S.	Penarth	Horta	46 30 N	12 50 W	3	8 a., 3	5	29.49	W.	W, 10	N.	W, 10	W-WNW-NNW-N.
Otho, Am. S. S.	New York	Dakar	36 56 N	68 45 W	4	4 a., 5	5	29.44	SE.	SW, 10	NW.	SW, 10	SSW-WSW-NW.
Westphalia, Ger. S. S.	Cobh	New York	49 05 N	26 30 W	5	8 p., 5	6	29.19	SSE.	SE, 9	NW.	NW, 9	SE-SSE.
Frederik VIII, Dan. S. S.	Oslo	Halifax	45 32 N	45 10 W	5	11 a., 6	7	29.18	SE.	SE, 10	WSW.	SE, 10	SE.
West Chatala, Am. S. S.	Galveston	Bremen	44 00 N	44 00 W	6	4 p., 6	6	29.26	SSE.	SSW, 7	S.	SSW, 10	S-SSW-SW-W.
Hoxie, Am. S. S.	New York	Glasgow	48 30 N	36 20 W	6	Mdt., 7	7	29.19	S.	S, 9	SW.	S, 10	S-SW.
Henri Jaspar, Belg. S. S.	Antwerp	New York	42 00 N	60 00 W	8	3 p., 8	8	28.98	SE.	SE, 8	NNW.	NW, 12	SE-SW.
Bellepline, Am. S. S.	do.	do.	43 10 N	55 19 W	8	8 p., 8	9	29.09	SSE.	SSE, 12	WNW.	SSE, 12	SSE-SSW-W.
Bellhaven, Am. S. S.	Cork	do.	51 00 N	40 00 W	9	8 a., 9	9	29.83	S.	SSE, 8	SW.	SSE, 10	
Waukegan, Am. S. S.	Havre	do.	45 50 N	40 50 W	9	8 p., 9	9	29.74	SSE.	S, 10	NW.	S, 10	S-W-NW.
Cold Harbor, Am. S. S.	Cork	do.	35 00 N	50 00 W	9	9 p., 9	10	29.89	S.	W, 8	N.	N, 10	SW-W-N.
Oarian, Br. S. S.	Savannah	Liverpool	47 02 N	37 47 W	8	6 a., 10	10	29.74	S.	S, 8	NW.	—, 10	S-SW-W-NW.
Milwaukee, Ger. M. S.	New York	Cherbourg	41 20 N	53 40 W	10	8 a., 11	11	29.70	SE.	S, 11	NW.	S, 11	SE-SW-S-NW.
West Hardaway, Am. S. S.	New Orleans	Bremen	41 30 N	47 30 W	12	8 p., 12	13	29.84	N.	N, 9	N.	N, 10	
Emile Francqui, Belg. S. S.	Antwerp	New York	45 49 N	41 20 W	13	6 a., 13	14	29.45	NNE.	NNE, 5	N.	N, 9	NNE-N.
Narcissus, Am. S. S.	Port Arthur	London	43 46 N	45 00 W	12	—, 14	16	29.68	NNE.	NNW, 11	N.	—, 11	NNE-NNW.
Cold Harbor, Am. S. S.	Cork	New York	37 30 N	68 30 W	13	5 a., 14	14	29.80	SE.	S, 12	NW.	S, 12	
Momus, Am. S. S.	New Orleans	do.	34 00 N	76 00 W	15	11 p., 15	16	29.75	N.	NNW, 8	NNW.	NNW, 10	
Bolton Castle, Br. S. S.	Algiers	do.	36 40 N	64 32 W	16	11 a., 16	17	29.74	W.	W, 8	NW.	WNW, 10	W-WNW-NW
Augustus, Ital. M. S.	Naples	do.	38 12 N	58 00 W	16	—, 16	16	29.50	SW.	SW, 11	WNW.	SW, 11	SW-WNW.
President Garfield, Am. S. S.	Gibraltar	do.	41 56 N	62 10 W	16	11 a., 16	17	29.17	SE.	SW, 10	NW.	W, 11	S-SW-W.
Tynefield, Br. M. S.	Baytown	EllesmerePort	47 00 N	25 00 W	24	8 a., 24	26	29.80	NNW.	NNW, 9	NNW.	NNW, 10	
Ariguani, Br. S. S.	Avonmouth	Cristobal	47 50 N	15 12 W	24	10 p., 24	25	29.53	SSE.	W, 8	NW.	W, 10	SSE-W.
Independence Hall, Am. S. S.	Havre	New York	49 00 N	17 10 W	25	2 a., 25	26	29.11	NW.	NW, 12	NW.	—, 12	
Georgia, Dan. S. S.	Bremen	Searsport, Me	47 55 N	37 50 W	26	8 p., 27	28	29.85	SE.	WSW	NW.	—, 10	SE-WSW.
West Isleta, Am. S. S.	Trinidad	Boston	32 55 N	67 18 W	27	5 a., 27	27	29.74	SW.	NW, 8	NNW.	NW, 10	SW-W-NW.
North Pacific Ocean													
Silverlarch, Br. M. S.	Manila	San Francisco	35 01 N	167 25 W	1	Noon, 2	2	29.07	SSW.	WSW, —	W.	NNW, 10	SSW-W.
Tenyo Maru, Jap. S. S.	Yokohama	Honolulu	34 29 N	159 59 E	2	Noon, 3	4	28.91	ENE.	WSW, 8	W.	W, 9	
Tamaha, Br. S. S.	San Pedro	Yokohama	32 00 N	161 12 E	3	2 p., 3	3	29.25	SW.	WSW, 10	W.	WSW, 10	Steady.
Do.	do.	do.	32 03 N	148 35 E	7	6 a., 7	7	28.91	N.	WSW, 6	N.	N, 11	SW-W.
Pennsylvania, Am. S. S.	Hong Kong	San Francisco	32 17 N	146 15 E	6	3 a., 7	7	29.07	E.	NNW, 6	N.	NNW, 11	W-NNW.
Steel Voyager, Am. S. S.	Los Angeles	Yokohama	30 25 N	153 55 E	7	3 p., 7	12	28.90	SW.	NW, 12	NW.	SW, 12	SW-NW.
Northwestern, Am. S. S.	Seattle	Seward	53 57 N	130 13 W	7	7 p., 8	9	29.00	SE.	SW, 6	SW.	SE, 10	
Dellwood, Am. S. S.	Yokohama	Seattle	49 30 N	135 00 W	8	1 a., 9	9	29.80	S.	S, —	S.	S, 10	S-SW.
Illinois, Am. S. S.	Hong Kong	San Francisco	32 04 N	146 00 E	8	6 a., 10	12	28.82	ESE.	SW, 11	WNW.	SW, 11	SW-W.
President Pierce, Am. S. S.	Seattle	Manila	50 30 N	133 00 W	9	11 p., 9	11	29.65	SE.		N.	W, 11	
Oregon, Am. S. S.	Otaru	San Francisco	43 01 N	169 45 E	9	10 a., 9	13	29.12	NE.	NE, 8	E.	NE, 10	Steady.
Melville Dollar, Am. S. S.	Yokohama	Los Angeles	40 10 N	150 42 E	10	4 p., 11	12	29.10	E.	N, 8	WNW.	E, 9	NE-N.
Reiyo Maru, Jap. S. S.	Whyalla	Kamaishi	26 29 N	144 50 E	10	4 p., 10	13	29.58	W.	WSW, 7	NW.	WNW, 9	WSW-WNW.
Golden Star, Am. S. S.	Shanghai	San Francisco	44 45 N	153 24 E	13	4 p., 13	14	29.34	NE.		NE.	NE, 9	Steady.
President Madison, Am. S. S.	San Francisco	Yokohama	28 53 N	158 34 E	13	2a., 15	15	29.67	W.	NW, —	NW.	W, 10	W-NW.
Mojave, Am. S. S.	Nagasaki	San Pedro	41 55 N	158 57 W	15	15	16	29.24	S.	S, 3	SW.	SW, 9	S-SW.
Moerdyk, Du. S. S.	Los Angeles	Balboa	15 17 N	95 01 W	16	4 a., 17	17	29.96	ENE.	NNE, 8	NNW.	N, 9	NE-N.
Korea Maru, Jap. S. S.	Yokohama	Honolulu	31 28 N	175 30 E	18	2 p., 19	19	29.49	ESE.	SW, 7	WNW.	SW, 9	ESE-SW.
Eknaren, Swed. M. S.	Manila	San Francisco	30 14 N	169 25 E	18	4 a., 19	19	29.33	ESE.	SW, 8	W.	W, 11	S-W.
Eclipse, Am. S. S.	do.	San Pedro	29 20 N	159 15 E	18	2 p., 18	20	29.80	WNW.	—, 6	N.	WNW, 9	WNW-NW.
Hakonesan Maru, Jap. M. S.	Yokohama	San Francisco	41 20 N	132 10 W	18	8 a., 19	20	28.97	ESE.	SSW, 6	W.	WSW, 10	S-SSW-W.
Havana Maru, Jap. S. S.	do.	Los Angeles	43 29 N	143 10 W	19	Noon, 20	20	28.82	SW.	SSW, 8	WSW.	S, 9	SSW-SW.
Los Alamos, Am. M. S.	Barnet	San Pedro	46 23 N	125 00 W	19	3 a., 20	22	29.14	SE.	SSE, 6	SE.	—, 10	SSE-S.
Admiral Rogers, Am. S. S.	Seattle	Kodiak	57 47 N	152 25 W	21	6 a., 21	22	28.52	NW.	NW, 8	NE.	NW, 9	NW-NE.
Admiral Peoples, Am. S. S.	San Francisco	Portland	44 30 N	124 30 W	21	6 a., 22	22	29.23	SE.	SE, 8	SW.	SE, 10	SE-ESE.
Africa Maru, Jap. S. S.	Yokohama	Victoria	46 42 N	168 58 E	21	4 p., 23	24	29.41	NW.	WNW, 8	W.	WNW, 10	WNW-W.
Kurohime Maru, Jap. S. S.	Vancouver	Yokohama	48 06 N	166 22 E	21	Noon, 22	24	28.81	W.	WNW, 11	W.	WNW, 12	Steady.
Chief Capilano, Br. S. S.	Shanghai	Vancouver	47 40 N	173 00 E	22	8 p., 22	23	28.76	W.	SW, 8	SW.	SW, 9	Do.
Golden Peak, Am. S. S.	Hong Kong	San Francisco	36 35 N	176 40 E	24	1 p., 24	25	29.01	S.	W, 9	WNW.	WSW, 12	WSW-WNW.
Tamaha, Br. S. S.	Yokohama	San Pedro	40 07 N	172 54 W	24	5 a., 24	25	28.98	SE.	SE, 4	NW.	NW, 11	S-Var.-NW.
Potter, Am. M. S.	Hong Kong	do.	34 41 N	166 33 E	24	4 a., 26	27	29.57	SW.	SW, 9	WNW.	SW, 9	SW-WSW.
Olympia Maru, Jap. S. S.	Yokohama	Seattle	47 52 N	178 50 W	25	8 p., 26	26	28.65	SW.	SSW, 6	WSW.	SW, 9	S-SW.
Siberia Maru, Jap. S. S.	do.	Victoria	49 36 N	172 06 W	24	Mdt., 27	28	29.06	E.	SE, 7	WSW.	NNE, 10	E-S.
Golden Wall, Am. S. S.	Shanghai	San Francisco	45 00 N	176 00 W	25	—, 27	28	29.22	S.	SSW, 11	WSW.	SSW, 11	S-SW.
President Jackson, Am. S. S.	Honolulu	Yokohama	33 48 N	162 07 E	27	Mdt., 28	28	29.25	SW.	SW, 8	NW.	SSW, 9	SSW-WSW.
President Taft, Am. S. S.	Seattle	do.	51 05 N	174 00 W	27	6 a., 28	28	28.23	SE.	SSW, 11	SSW.	S, 12	S-SSW.

NORTH PACIFIC OCEAN

By WILLIS E. HURD

Another remarkable change in atmospheric pressure since a preceding month this year took place over the North Pacific Ocean during February. In January we saw the Aleutian cyclone extending abnormally low in latitude, being central well to the southward of the Aleutian chain and influencing pressure in an unusual degree as far south as Midway Island. The Gulf of Alaska at the same time was covered for the most part by the southern extension of an anticyclone of great magnitude from the north. In February a violent fluctuation back toward normal occurred in upper northeastern waters, with the result that the great plus departures of pressure in January gave place to the considerable negative departures of February, Juneau's abnormality dropping from +0.45 to −0.36 inch, and Kodiak's from +0.56 to −0.31 inch, a truly extraordinary reversal. Actually, there was a fall of close to nine-tenths of an inch in pressure over the upper waters of the Gulf of Alaska. Here in February lay the average center of the Aleutian cyclone, though its lower extension, as in the previous month, overran Midway Island, thus covering as a whole an unusually large northeast-southwest section of the sea.

The California-Pacific anticyclone, though at times spreading to normal area, was for the greater part of the month displaced on the northwest by cyclonic conditions, and continued stable only from the California coast southwestward to the Hawaiian Islands.

In Asiatic waters the overrunning continental anticyclone normal to winter was frequently displaced this month by numerous depressions of both land and oceanic origin.

Barometric data for several island and coast stations in west longitudes, including Point Barrow on the Arctic Ocean, are given in the following table:

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level at indicated hours, North Pacific Ocean and adjacent waters, February, 1930*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow [1] [3]	29.94		30.44	25th	29.54	4th.
Dutch Harbor [1]	29.74	+0.12	30.52	11th	29.12	28th.
St. Paul [1]	29.84	+0.18	30.54	10th	28.70	28th.
Kodiak [1]	29.39	−0.31	30.24	11th	28.66	22d.
Midway Island [1]	29.92	−0.11	30.30	25th	29.40	14th.
Honolulu [3]	30.04	0.00	30.19	23d	29.79	13th.
Juneau [3]	29.56	−0.36	30.49	26th	28.89	7th.
Tatoosh Island [3] [4]	29.94	−0.04	30.42	8th	29.03	20th.
San Francisco [3] [4]	30.09	+0.02	30.33	28th	29.61	22d.
San Diego [3] [4]	30.06	+0.02	30.27	28th	29.84	3d.

[1] P. m. observations only.
[2] For 27 days.
[3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean.

Although February, so far as now indicated by reports, seems not to have produced weather of quite the severity of January, it was nevertheless a stormy month, especially over that part of the ocean lying west of the one hundred and seventieth meridian of west longitude, between latitudes 25° and 50° N. Within this region full storm to hurricane velocities were reported on at least nine days, namely, the 7th, 8th, 10th, 11th, 19th, 22d, 24th, 27th, and 28th. Those of the 7th to 11th, occurring between longitude 155° E. and the lower Japanese coast, were associated with a violent typhoon which, coming up from the southward, where it was strongly developed near the Ogasawara Islands on the 8th, affected southern and eastern Hondo on the 9th and 10th, respectively, and proceeding northeastward, caused fresh to strong gales east of the Kuril Islands as late as the 13th.

The region of quietest weather for all that part of the ocean north of the twenty-fifth parallel lay between longitudes 150° and 170° W. Here gales were local and scattered, mostly of no higher force than fresh to strong and occurring on five or six days only. For more than half of this area not a single gale was reported.

Farther eastward storminess increased in frequency and to some degree in severity to the American continent although not attaining to the rigorousness experienced in east longitudes. From near San Francisco northward to Vancouver Island an unusual amount of rough weather for the locality occurred, shifting gales of force 8 to 10 being encountered by vessels at various places along the coast from the 19th to the 24th. The earlier of these gales was due to the presence of a secondary to the great ocean cyclone then centered to the northwestward. This storm threatened the coastal region for hundreds of miles, but finally, with central pressure about 29 inches or lower, entered the mainland near Prince Rupert on the 20th. The succeeding coastal gales until the 24th resulted from active pressure gradients along the eastern edge of the huge Aleutian storm.

On the 4th, from the 18th to the 22d, and on the 28th, fresh westerly to northwesterly gales were experienced by vessels on the California-Hawaiian routes at varying distances of one or more days' steaming from the coast. The severest weather reported in west longitudes occurred during the night of the 10th-11th near 50° N., 140° W., where the steamship *President Pierce* encountered westerly gales of force 11. Along the Alaskan coast fresh to whole gales occurred on several dates—on the 7th and 8th south of Sitka, and on the 21st, 22d, and 28th north of Kodiak.

Northers of force 8 to 9 were encountered in the Gulf of Tehuantepec on the 8th, 9th, 16th, 17th, and 18th. Maximum wind velocities exceeding 50 miles an hour from a northerly direction were reported as follows from Santa Cruz at the head of the gulf: On the 17th, 56; 18th, 64; 19th, 64 miles.

The prevailing wind direction at Honolulu was from northeast, with the maximum velocity at the rate of 31 miles an hour from the east on the 27th. The average wind velocity at this station was the second lowest for the month since 1905.

Few and isolated instances of fog occurred in east longitudes. Along that part of the upper steamship routes south of the eastern Aleutians and the lower western half of the Gulf of Alaska fog was rather widespread in formation on the 10th to 16th and the 26th to 28th. Along the American coast between 25° and 50° N. and for some distance west of California fog showed greatest frequency, approximating 40 per cent of the days. It occurred on at least four days off Lower California and on the 16th off the Guatemalan coast.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, February, 1930

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	53.9	+5.6	Camp Hill	86	24	Valley Head	19	15	2.28	−3.02	Florence	3.87	Dadeville	0.95
Arizona	51.1	+3.7	Litchton	93	16	Williams	−6	28	0.46	−0.68	Oracle	2.10	6 stations	0.00
Arkansas	52.2	+9.4	Dardanelle	86	26	2 stations	16	16	3.92	+0.57	Springbank	6.18	Mena	1.60
California	50.5	+3.3	Betteravia	94	17	Twin Lakes	−10	24	2.87	−1.57	Upper Mattole	11.75	3 stations	0.00
Colorado	33.5	+6.1	Canon City	82	6	Steamboat Springs	−35	11	0.69	−0.32	Silver Lake	6.64	do	0.00
Florida	63.6	+3.3	Orlando	89	28	Penney Farms	27	1	3.12	−0.02	West Palm Beach	7.34	Apalachicola	1.26
Georgia	53.7	+5.7	Quitman	87	25	Clayton	11	1	1.61	−3.39	Brunswick	4.21	Montezuma	0.52
Idaho	35.0	+6.4	Meridian	70	15	Big Springs	−15	24	2.25	+0.38	Roland	6.63	Challis	0.46
Illinois	40.2	+11.7	Carlinville	82	24	2 stations	−7	15	2.02	+0.07	Mount Carmel	4.62	Warsaw	0.61
Indiana	40.6	+11.0	Scottsburg	79	19	Valparaiso	−3	16	2.49	−0.05	Jeffersonville	4.37	Plymouth	0.48
Iowa	35.5	+12.9	2 stations	80	24	Webster City	−34	15	0.67	−0.54	Fairport	2.45	Red Oak	0.06
Kansas	46.3	+13.9	do	85	23	Atchison	−3	15	0.31	−0.82	Columbus	1.98	10 stations	0.00
Kentucky	45.1	+8.5	Beaver Dam	80	25	2 stations	2	16	3.49	+0.04	Hopkinsville	5.05	Pikeville	2.26
Louisiana	59.0	+5.8	Ruston	84	24	3 stations	25	[2]1	3.51	−0.98	Hammond	5.62	Dalcour	1.92
Maryland-Delaware	39.4	+6.4	Newburg, Md	85	25	Oakland, Md	−20	16	2.06	−0.98	Stevensville, Md	3.36	Princess Anne, Md.	1.14
Michigan	27.2	+7.8	2 stations	69	[2]21	Sidnaw	−36	15	1.76	+0.06	Alma	3.39	Mackinac Island	0.38
Minnesota	23.1	+11.3	Tracy	65	20	Pokegama Falls	−41	15	1.25	+0.52	Redby	3.27	Tracy	0.08
Mississippi	55.8	+6.6	Port Gibson	84	25	2 stations	21	16	3.38	−1.51	Lake	5.33	2 stations	1.30
Missouri	44.5	+12.1	Jefferson City	89	24	Downing	−5	15	1.71	−0.40	New Madrid	4.42	Warrensburg	0.15
Montana	32.0	+11.0	Chinook	76	19	Outlook	−23	14	0.59	−0.13	Heron	4.90	3 stations	T.
Nebraska	39.7	+14.1	Merriman	85	16	Walthill	−11	14	0.39	−0.33	Gordon	1.46	2 stations	0.00
Nevada	40.5	+4.8	Las Vegas	89	15	Lamoille	−2	28	0.77	−0.26	Marlette Lake	4.72	do	0.00
New England	25.5	+3.0	Springfield, Mass	74	20	2 stations	−37	[2]6	2.06	−1.15	Ellsworth, Me	4.56	Burlington, Vt	0.48
New Jersey	35.6	+6.2	Pleasantville	80	25	Layton	−10	17	2.80	−0.80	Asbury Park	5.13	Cape May City	1.07
New Mexico	41.7	+4.5	2 stations	82	[2]7	2 stations	−18	1	0.25	−0.42	Winsor's Ranch	1.43	38 stations	0.00
New York	28.0	+5.8	Port Jervis	75	25	Stillwater	−40	17	1.72	−1.01	Taberg	5.22	Chazy	0.20
North Carolina	47.1	+4.8	Newbern	86	[2]25	Banners Elk	−2	1	1.34	−2.76	Andrews	3.02	Brevard	0.30
North Dakota	21.7	+13.8	Fort Yates	63	19	3 stations	−30	[2]14	1.18	+0.69	2 stations	2.50	Tagus	0.11
Ohio	38.7	+9.3	Middleport	81	25	do	−6	16	2.63	+0.24	Bellefontaine	4.64	Paulding	1.20
Oklahoma	51.3	+10.2	Mangum	93	24	Beaver	12	10	1.24	−0.04	Ardmore	5.31	3 stations	0.00
Oregon	41.4	+4.5	Marshfield	79	17	Sand Creek	−10	28	4.51	+0.16	Valsetz	20.75	Madras	0.26
Pennsylvania	35.1	+7.4	Quakertown	80	25	Brookville	−18	16	2.69	+0.03	Cresson	4.88	Lloyd	0.93
South Carolina	51.6	+4.2	Yemassee	88	22	Caesar's Head	12	16	1.12	−3.21	Caesar's Head	3.93	Aiken	0.52
South Dakota	33.2	+15.2	Academy	78	18	Webster	−20	15	0.72	+0.01	Mobridge	2.60	Orman	0.02
Tennessee	48.5	+7.5	Clarksville	82	25	Johnson City	8	1	4.06	−0.28	Crossville	6.84	Johnson City	1.59
Texas	57.5	+7.0	Riogrande	96	24	Spearman	11	10	1.53	−0.33	Dialville	5.78	39 stations	0.00
Utah	35.2	+4.4	St. George	77	17	Woodruff	−11	4	1.12	−0.21	Silver Lake	4.52	3 stations	0.00
Virginia	43.7	+6.5	2 stations	86	25	Burkes Garden	−7	16	1.46	−1.61	Onley	3.17	Winchester	0.48
Washington	37.6	+3.2	Kiona	70	18	Laurier	−7	14	5.86	+1.30	Big Four	30.19	Irene Mountain	0.43
West Virginia	39.8	+7.6	2 stations	81	[2]24	3 stations	−21	16	2.62	−0.47	Pickens	5.21	Brandywine	0.93
Wisconsin	25.3	+9.6	High Falls	68	22	Solon Springs	−36	15	1.40	+0.23	Sturgeon Bay	3.50	Prairie du Chien	0.20
Wyoming	30.5	+9.0	Torrington	70	20	Riverside	−17	28	0.64	−0.14	Kendall	3.53	Wamsutter	T.
Alaska [January]	7.1	+3.2	Yakutat	58	19	Fort Yukon	−50	3	1.31	−1.16	Chignik	29.86	Fort Yukon	0.10
Hawaii	70.4	+1.8	Kaanapali	92	26	Puu Kapele	44	15	6.57	+0.38	Waiakamoi	28.52	Ka Lae	0.00
Porto Rico	73.0	−0.4	Mayaguez	91	17	Guineo Reservoir	49	4	1.96	−0.96	Rio Blanco	5.73	Utuado	0.00

[1] For description of tables and charts, see REVIEW, January, 1930, p. 37.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, February, 1930*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*° F.*	*° F.*	*°F.*		*°F.*	*°F.*		*°F.*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							28.9	+3.5										76	2.40	−0.9										5.2		
Eastport	76	67	85	29.90	29.99	+0.01	22.9	+1.4	42	14	32	−8	17	14	32	21	17	77	4.47	+1.1	15	6,891	nw.	38	nw.	16	8	3	17	6.5	18.6	T.
Greenville, Me.	1,070	6	----	28.79	30.01	------	16.8	------	54	24	28	−24	7	5	35	------	------	------	1.81	------	8	5,573	se.	30	------	11	12	11	5	----	10.5	----
Portland, Me.	103	82	117	29.92	30.05	+.03	26.4	+2.6	55	20	34	−5	17	18	29	23	18	72	2.15	−1.8	14	4,991	n.	29	nw.	16	14	3	11	5.0	9.4	0.1
Concord	289	70	79	29.71	30.04	.00	25.6	+2.8	66	20	37	−8	12	14	39	------	------	------	0.87	−2.0	8	3,348	nw.	27	nw.	16	14	6	8	4.7	6.6	0.0
Burlington	403	11	48	29.60	30.07	+.04	20.8	+1.4	56	20	30	−16	17	12	36	------	------	------	0.48	−1.1	11	7,222	s.	39	s.	12	7	6	15	6.6	5.1	T.
Northfield	876	12	60	------	30.06	+.02	19.8	+3.4	61	20	31	−18	17	8	40	------	------	------	0.93	−1.3	10	4,114	n.	21	s.	12	8	8	12	6.2	4.7	T.
Boston	125	106	165	29.91	30.05	+.01	34.1	+5.3	68	20	43	−1	17	25	29	29	23	66	2.23	−1.1	12	5,455	nw.	34	nw.	16	14	8	6	4.7	9.5	0.0
Nantucket	12	14	90	30.03	30.04	.00	33.3	+2.6	60	21	40	5	17	26	28	31	28	84	3.41	0.0	12	9,478	sw.	42	sw.	14	13	8	7	4.9	11.8	0.0
Block Island	26	11	46	30.02	30.05	.00	34.2	+3.8	57	21	41	5	17	28	21	30	28	81	3.95	+0.3	12	10,720	sw.	56	nw.	16	10	12	6	4.7	8.4	T.
Providence	160	215	251	29.88	30.06	+.01	33.6	+4.6	69	20	43	−2	17	25	27	29	23	68	2.57	−1.1	11	6,846	nw.	44	nw.	16	15	5	8	4.3	7.5	T.
Hartford	159	122	----	29.89	30.07	+.01	32.8	+5.6	69	20	42	−1	17	24	29	------	------	------	2.05	−1.8	13	------	sw.	------	------	------	10	10	8	5.0	6.5	T.
New Haven	106	74	153	29.96	30.09	+.02	34.0	+5.0	69	20	42	1	17	26	29	30	25	74	3.27	−0.7	15	5,316	s.	26	nw.	16	14	7	7	4.5	5.9	0.0
Middle Atlantic States							39.4	+6.0										71	2.09	−1.1									5.4		
Albany	97	107	115	29.98	30.09	+.02	28.8	+4.7	66	20	38	−6	17	20	30	25	21	77	1.04	−1.4	11	4,332	s.	28	se.	12	12	6	10	5.1	5.9	0.5
Binghamton	871	10	84	29.11	30.07	−.01	30.0	+6.0	65	25	40	−6	17	21	36	------	------	------	1.62	−0.6	12	3,471	nw.	18	nw.	10	9	2	17	6.8	3.7	T.
New York	314	414	454	29.74	30.09	+.01	37.0	+5.7	73	25	45	7	16	29	36	32	26	67	3.40	−0.4	11	9,868	nw.	58	w.	10	5	11	12	6.1	3.6	0.0
Bellefonte	1,050	5	36	28.94	30.08	------	31.6	------	67	25	42	−5	16	21	34	28	24	78	2.71	------	13	------	sw.	------	------	------	5	5	18	7.8	5.0	0.0
Harrisburg	374	94	104	29.70	30.12	+.03	37.0	+6.8	74	25	46	5	16	28	32	32	26	66	2.75	−0.2	9	3,661	w.	24	sw.	10	8	8	12	6.4	2.7	0.0
Philadelphia	114	123	367	29.99	30.12	+.02	40.1	+6.2	79	25	48	8	16	32	29	34	27	64	3.65	+0.3	9	8,182	sw.	35	n.	16	9	8	11	5.5	1.5	0.0
Reading	325	81	98	29.75	30.12	------	37.6	+8.8	77	25	46	6	16	29	34	33	28	71	2.60	−0.8	10	3,679	w.	20	w.	10	8	8	12	6.0	2.5	0.0
Scranton	805	111	119	29.20	30.10	+.02	32.4	+5.1	67	25	41	1	17	24	28	29	26	78	1.87	−1.2	10	4,153	sw.	23	nw.	10	5	11	12	6.6	4.3	T.
Atlantic City	52	37	172	30.05	30.11	.00	39.4	+5.8	77	25	47	8	16	32	33	34	30	74	2.07	−1.3	10	10,154	nw.	42	s.	13	9	13	6	5.1	3.6	0.0
Cape May	17	13	49	------	------	------	39.2	+5.1	74	20	48	8	17	31	33	35	31	80	1.07	−2.2	10	------	nw.	------	------	------	10	10	8	----	5.7	0.0
Sandy Hook	22	10	55	30.06	30.08	------	35.8	------	68	25	42	9	16	29	28	32	28	75	3.63	−0.1	12	8,809	w.	48	nw.	16	8	11	9	5.4	4.1	0.0
Trenton	190	159	183	29.89	30.10	------	37.6	+6.9	76	25	47	6	16	28	34	32	27	70	3.81	+0.5	11	5,914	sw.	29	nw.	10	9	7	12	5.7	2.7	0.0
Baltimore	123	100	215	29.97	30.11	.00	42.0	+6.6	83	25	51	9	16	33	36	31	29	69	2.38	−1.0	8	5,685	sw.	32	sw.	10	12	7	9	5.5	3.4	0.0
Washington	112	62	85	29.99	30.12	+.01	41.9	+6.6	84	25	52	7	16	32	37	36	29	64	1.64	−1.6	7	3,677	nw.	28	nw.	13	12	5	11	5.2	1.5	0.0
Cape Henry	18	8	54	30.09	30.11	------	46.4	+5.2	84	25	55	20	16	37	38	41	38	78	1.84	−1.4	6	6,688	sw.	44	n.	15	15	9	4	3.8	0.8	0.0
Lynchburg	681	153	188	29.37	30.13	+.02	45.8	+5.5	81	25	57	17	16	34	38	37	29	57	0.95	−2.2	7	4,384	w.	29	nw.	27	13	9	6	4.2	0.2	0.0
Norfolk	91	170	205	30.04	30.14	+.03	48.2	+5.5	81	25	58	15	16	39	32	41	36	72	1.24	−2.0	6	7,265	s.	34	w.	10	13	10	8	3.9	1.0	0.0
Richmond	144	11	52	29.97	30.14	+.03	45.3	+5.7	82	25	57	11	16	34	37	38	32	67	1.21	−2.0	4	4,804	sw.	34	w.	26	16	8	4	3.9	2.5	0.0
Wytheville	2,304	49	55	27.69	30.13	+.01	41.6	+6.5	71	25	52	10	16	31	36	35	29	68	0.88	−2.1	7	4,320	w.	24	nw.	27	14	9	5	4.1	0.2	0.0
South Atlantic States							53.0	+5.1										68	1.03	−2.7									3.4		
Asheville	2,253	70	84	27.75	30.17	+.04	44.2	+5.7	78	25	56	13	1	33	34	36	30	64	0.67	−2.5	5	4,902	nw.	28	n.	10	16	9	3	3.4	T.	0.0
Charlotte	779	55	62	29.29	30.14	+.02	50.6	+6.7	82	25	61	22	16	40	31	42	35	62	0.92	−3.3	4	3,190	s.	23	sw.	26	18	5	8	3.1	0.0	0.0
Greensboro	886	5	56	29.17	30.15	------	44.6	------	81	25	58	11	1	31	42	37	33	76	1.25	------	3	4,698	sw.	27	nw.	26	16	6	6	3.7	T.	0.0
Hatteras	11	5	50	30.12	30.13	+.02	51.6	+4.2	73	25	59	29	16	44	23	47	44	81	0.73	−3.3	5	7,631	ne.	37	n.	16	17	6	8	3.3	0.0	0.0
Raleigh	376	103	110	29.73	30.14	+.03	49.6	+6.4	82	25	61	22	16	39	32	42	35	65	1.18	−2.7	4	3,843	sw.	27	nw.	26	21	3	4	3.0	T.	0.0
Wilmington	78	81	91	30.07	30.16	+.04	53.2	+5.3	81	25	63	25	17	43	30	45	41	73	0.38	−2.9	2	4,032	sw.	24	sw.	4	18	5	8	3.3	0.0	0.0
Charleston	48	11	92	30.11	30.16	+.04	55.7	+3.3	81	24	64	34	17	48	24	49	45	76	0.81	−2.2	3	5,696	sw.	26	n.	16	17	7	4	3.4	0.0	0.0
Columbia, S. C.	351	41	57	29.77	30.16	+.05	53.4	+5.2	83	25	64	27	17	43	32	44	36	60	0.65	−3.1	4	4,002	sw.	27	sw.	26	16	9	3	3.2	0.0	0.0
Due West	711	10	55	29.40	30.19	------	50.8	------	79	24	62	26	16	40	32	------	------	------	0.92	------	5	4,965	sw.	27	w.	26	17	6	5	3.2	0.0	0.0
Greenville, S. C.	1,039	139	146	29.03	30.14	------	50.6	+7.3	79	25	60	23	16	41	28	42	34	59	1.24	−3.9	6	4,689	sw.	30	n.	16	19	5	4	3.1	T.	0.0
Augusta	182	62	77	29.95	30.14	+.02	54.8	+4.9	83	25	67	29	1	43	36	45	38	62	0.96	−3.2	4	2,780	nw.	18	w.	26	17	8	3	3.2	0.0	0.0
Savannah	65	150	194	30.08	30.15	+.03	58.0	+4.0	82	24	67	34	17	49	28	49	44	71	1.13	−2.0	5	6,598	w.	25	sw.	26	15	5	8	4.1	0.0	0.0
Jacksonville	43	209	245	30.10	30.15	+.03	60.8	+2.8	81	25	69	41	17	53	30	53	48	73	2.61	−0.4	7	6,505	ne.	37	sw.	4	11	7	10	4.7	0.0	0.0
Florida Peninsula							69.4	+2.9										79	3.35	+1.4									3.9		
Key West	22	10	64	30.05	30.07	.00	72.2	+1.7	83	5	77	60	1	67	15	66	64	81	2.86	+1.5	8	6,225	ne.	33	sw.	7	16	6	6	3.4	0.0	0.0
Miami	25	124	168	30.07	30.10	−.01	70.5	+3.4	81	5	76	51	1	65	22	64	60	74	3.86	+2.0	8	5,922	e.	38	ne	17	12	9	7	4.8	0.0	0.0
Tampa	35	79	197	30.08	30.12	+.02	65.5	+3.6	83	28	75	41	1	56	29	59	56	83	3.34	+0.8	4	6,672	n.	36	ne.	7	12	10	6	4.3	0.0	0.0
Titusville	44	5	----	30.09	30.14	------	64.4	------	86	26	75	36	1	54	33	------	------	------	1.67	------	4	------	nw.	------	------	------	----	----	----	3.0	0.0	0.0
East Gulf States							56.0	+4.7										71	2.20	−2.6									4.4		
Atlanta	1,173	190	216	28.90	30.15	+.03	51.8	+6.5	77	25	61	24	16	42	27	45	39	66	1.02	−3.8	6	6,479	nw.	31	w.	4	15	8	5	3.8	0.0	0.0
Macon	370	78	87	29.76	30.16	+.04	53.0	+3.7	82	25	65	27	1	41	37	44	37	64	2.04	−2.4	4	3,463	s.	22	nw.	13	18	6	4	3.0	0.0	0.0
Thomasville	273	49	58	29.85	30.15	+.03	58.6	+3.6	81	26	69	34	17	48	29	50	44	70	3.17	−1.3	6	2,623	ne.	22	sw.	4	11	7	10	4.8	0.0	0.0
Apalachicola	36	11	51	30.10	30.14	------	58.8	------	76	26	66	38	17	52	23	54	52	82	1.26	−2.6	4	4,652	e.	26	ne.	16	12	9	7	4.2	0.0	0.0
Pensacola	56	149	185	30.08	30.14	+.03	58.7	+3.5	75	26	65	33	16	53	22	54	51	81	2.24	−2.1	7	7,297	e.	46	s.	4	11	8	9	4.8	0.0	0.0
Anniston	741	9	57	29.37	30.18	+.06	51.6	+5.8	82	25	64	24	11	39	38	------	------	------	1.56	−3.9	8	3,383	s.	22	se.	28	15	8	5	3.5	0.0	0.0
Birmingham	700	11	48	29.38	30.16	+.04	54.0	+6.0	81	25	64	25	16	44	30	45	38	62	1.71	−3.4	7	4,858	s.	29	se.	28	14	8	6	4.4	0.0	0.0
Mobile	57	125	161	30.07	30.13	+.02	58.4	+3.7	76	26	67	33	16	50	28	52	49	78	1.94	−3.4	6	5,481	s.	31	nw.	15	8	8	12	5.5	0.0	0.0
Montgomery	223	100	112	29.91	30.16	+.04	55.5	+3.9	80	25	66	30	16	45	30	48	40	63	2.69	−2.8	8	3,962	s.	22	n.	15	10	11	7	4.6	0.0	0.0
Corinth	469	6	----	------	29.25	------	52.8	------	79	25	64	22	16	41	38	------	------	------	4.28	------	10	------	se.	------	------	------	7	17	4	----	0.0	0.0
Meridian	375	87	95	29.73	30.13	+.02	55.1	+5.5	80	25	66	27	16	44	34	48	43	71	3.11	−2.3	8	3,481	s.	26	se.	28	12	7	9	4.7	0.0	0.0
Vicksburg	247	65	73	29.84	30.13	+.03	57.2	+5.4	80	25	66	30	16	48	26	49	42	65	2.72	−2.1	8	4,512	s.	23	s.	3	12	9	7	4.5	0.0	0.0
New Orleans	53	76	84	30.06	30.12	+.03	61.6	+4.3	79	13	70	35	16	54	22	56	54	84	2.98	−1.3	7	3,966	se.	23	ne.	15	10	8	10	5.4	0.0	0.0
West Gulf States							58.4	+6.8										76	2.31	−0.2									5.3		
Shreveport	249	77	93	29.81	30.09	.00	57.4	+6.5	79	24	66	33	16	49	27	51	46	73	4.72	+1.4	11	3,886	s.	24	ne.	10	10	6	12	5.6	0.0	0.0
Bentonville	1,303	11	44	28.64	30.02	−.08	48.8	+10.3	76	23	60	23	10	38	33	------	------	------	3.34	------	6	4,933	s.	25	s.	20	15	6	7	----	0.0	0.0
Fort Smith	457	79	94	29.56	30.04	−.06	53.0	+10.2	80	23	63	29	16	43	33	46	40	69	1.91	−0.6	5	4,706	e.	32	w.	25	10	10	8	5.0	0.0	0.0
Little Rock	357	136	153	29.70	30.08	−.03	54.0	+9.1	79	23	63	30	16	45	32	47	40	66	4.40	+0.6	9	6,048	sw.	31	n.	15	9	9	10	5.5	0.0	0.0
Austin	605	136	148	29.40	30.03	------	59.6	+6.2	86	22	70	35	17	49	37	53	49	74	1.70	−0.6	7	5,327	s.	26	n.	15	9	10	9	5.2	0.0	0.0
Brownsville	57	83	100	29.97	30.03	------	66.6	+4.0	83	13	75	46	6	58	30	61	58	84	1.09	−0.1	4	7,264	se.	34	n.	15	8	12	8	5.3	0.0	0.0
Corpus Christi	20	11	78	30.02	30.04	−.01	63.0	+4.6	78	22	70	45	16	56	24	59	56	85	0.37	−1.1	7	6,858	e.	32	n.	15	8	8	12	6.0	0.0	0.0
Dallas	512	220	227	29.49	30.04	------	56.4	------	80	22	66	34	16	47	31	------	------	------	1.90	−0.4	8	8,257	se.	39	n.	9	17	5	6	3.3	0.0	0.0
Fort Worth	670	106	114	29.30	30.02	−.05	57.6	+0.3	82	22	68	33	16	47	35	50	44	68	1.08	−0.7	9	6,089	s.	25	n.	11	12	8	8	4.6	0.0	0.0
Galveston	54	106	114	30.04	30.10	+.03	60.0	+3.7	74	13	65	40	16	55	15	57	56	91	2.74	−0.1	6	6,618	se.	28	nw.	15	10	6	12	5.5	0.0	0.0
Groesbeck	461	11	56	29.56	30.05	------	57.8	------	81	22	67	31	16	49	31	------	------	------	2.27	−0.6	8	7,277	s.	30	n.	15	10	9	9	5.1	0.0	0.0
Houston	138	292	314	29.92	30.07	------	61.2	+5.3	81	22	69	37	16	53	24	------	------	------	2.34	−0.8	9	7,757	se.	36	n.	15	9	5	14	6.0	0.0	0.0
Palestine	510	64	72	29.53	30.06	−.02	57.6	+6.4	83	22	66	32	16	49	28	53	51	82	4.21	+1.2	8	5,300	s.	23	sw.	12	8	8	12	5.9	0.0	0.0
Port Arthur	34	58	66	30.05	30.09	------	60.4	------	76	13	68	35	16	53	23	------	------	------	2.46	−1.1	7	4,560	s.	34	n.	15	9	5	14	5.9	0.0	0.0
San Antonio	693	119	132	29.30	30.03	−.02	61.6	+6.2	86	22	72	37	16	52	35	54	49	68	0.94	−0.7	5	4,159	se.	30	nw.	25	8	11	9	5.3	0.0	0.0
Taylor	583	55	63	29.46	30.08	+.02	58.4	+7.1	83	22	68	34	16	48	32	----	----	----	2.47	+0.4	8	5,628	s.	26	s.	24	11	8	9	5.1	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, February, 1930*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F.*		°*F.*	° *F.*		°*F.*	° *F.*	° *F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							44.2	+8.2										70	3.05	−0.3										6.2		
Chattanooga	762	190	215	29.33	30.16	+0.03	50.1	+6.0	79	25	60	22	16	40	31	42	33	58	3.25	−1.6	9	5,050	sw.	34	nw.	13	14	5	9	4.5	0.0	0.0
Knoxville	995	102	111	29.07	30.15	+.03	47.9	+6.0	75	25	59	18	16	37	35	41	35	68	3.78	−0.7	9	3,915	sw.	32	sw.	9	14	8	6	4.1	T.	0.0
Memphis	399	76	97	29.67	30.10	−.01	52.7	+8.4	78	25	60	25	16	45	24	47	41	70	4.78	+0.4	10	5,183	sw.	32	sw.	4	11	6	11	5.0	0.0	0.0
Nashville	546	168	191	29.55	30.15	+.03	49.3	+7.7	74	25	59	21	16	40	34	43	36	66	3.68	−0.4	10	5,826	s.	33	s.	12	9	9	10	5.5	T.	0.0
Lexington	989	193	230	29.04	30.14	+.03	43.8	+8.4	69	25	52	10	16	36	27	----	----	----	2.91	−0.7	10	8,853	sw.	40	w.	9	11	6	11	5.4	1.3	0.0
Louisville	525	188	234	29.53	30.12	+.01	46.0	+8.8	74	25	54	15	16	38	25	40	34	67	3.86	+0.3	8	7,112	s.	44	nw.	25	7	11	10	6.0	0.1	0.0
Evansville	431	76	116	29.62	30.10	−.01	45.4	+9.1	72	25	53	18	16	38	26	40	35	72	3.12	−0.1	8	6,206	s.	30	sw.	24	6	9	13	6.4	2.8	0.0
Indianapolis	822	194	230	29.16	30.07	+.03	41.6	+10.5	69	19	49	13	16	34	25	36	30	69	2.76	0.0	7	7,272	s.	32	w.	10	4	12	12	6.5	1.2	0.0
Royal Center	736	11	55	29.23	30.05	------	38.0	------	68	21	45	7	15	31	27	----	----	----	1.58	−0.8	5	6,872	sw.	32	w.	10	5	10	13	6.9	0.2	0.0
Terre Haute	575	96	129	29.44	30.07	------	41.9	------	70	19	49	12	16	35	27	37	32	73	2.21	−0.4	8	6,061	s.	27	sw.	22	9	6	13	6.1	1.5	0.0
Cincinnati	627	11	51	29.40	30.10	.00	43.0	+10.2	72	25	51	8	16	35	29	37	32	72	2.95	0.0	8	4,990	sw.	24	sw.	12	7	9	12	6.2	1.5	0.0
Columbus	822	179	222	29.18	30.08	−.01	40.4	+9.7	70	22	48	8	16	33	28	36	31	72	3.45	+0.8	10	6,369	s.	38	nw.	10	3	6	19	7.6	0.7	0.0
Dayton	899	137	173	29.10	30.08	------	41.7	+10.3	69	25	48	10	16	35	26	37	32	74	2.31	−0.4	10	5,956	sw.	28	nw.	10	3	12	13	7.0	0.7	0.0
Elkins	1,947	59	67	28.02	30.14	+.03	36.9	+5.3	70	25	48	−14	16	25	43	32	28	76	2.78	−0.3	13	3,520	w.	34	w.	26	7	4	17	6.8	8.2	0.0
Parkersburg	637	77	82	29.45	30.12	+.02	41.4	+7.2	77	25	51	5	16	32	37	36	30	68	2.30	−0.8	10	3,743	se.	28	nw.	26	8	2	18	7.1	0.1	0.0
Pittsburgh	842	353	410	29.16	30.09	.00	39.0	+6.7	70	22	47	4	16	31	30	35	29	70	3.12	+0.5	12	6,430	sw.	38	w.	26	2	9	17	7.7	1.2	0.0
Lower Lake Region							31.7	+6.8										78	1.55	−0.9										7.2		
Buffalo	767	247	280	29.18	30.03	−.03	29.0	+4.7	66	22	37	−1	16	22	31	27	24	82	2.20	−0.8	17	10,250	sw.	58	sw.	14	6	8	14	7.1	10.1	0.6
Canton	448	10	61	29.55	30.05	------	18.8	+0.8	56	23	29	−30	6	9	39	----	----	----	0.50	−1.8	12	5,843	sw.	34	sw.	13	7	9	12	6.1	7.4	0.0
Ithaca	836	5	100	29.13	30.07	------	29.0	+4.5	66	20	38	−8	17	20	34	26	22	78	1.45	−0.5	14	6,048	s.	34	se.	12	2	4	22	8.0	7.2	T.
Oswego	335	76	91	29.68	30.06	.00	26.8	+2.9	58	24	35	−8	17	19	30	24	21	80	1.28	−1.4	15	6,676	se.	28	w.	10	1	9	18	7.8	16.3	2.2
Rochester	523	86	102	29.47	30.06	.00	30.1	+5.5	67	22	38	3	16	22	31	26	22	72	1.90	−0.8	17	5,592	sw.	34	sw.	14	5	6	17	7.3	12.6	0.5
Syracuse	596	65	79	29.40	30.06	−.01	29.9	+6.1	65	22	38	−7	6	22	32	----	----	----	1.03	−1.7	14	4,463	s.	22	s.	12	7	6	15	6.9	4.7	0.8
Erie	714	130	166	29.26	30.05	−.02	33.6	+6.7	69	22	41	−1	16	26	33	31	27	78	1.53	−1.0	11	8,682	s.	38	sw.	14	4	8	16	7.1	2.5	T.
Cleveland	762	267	337	29.20	30.04	−.03	37.5	+10.1	72	22	45	7	15	30	34	34	29	73	2.45	−0.1	14	9,389	s.	38	s.	12	4	6	18	7.8	4.8	T.
Sandusky	629	5	67	29.34	30.04	−.03	37.0	+9.6	70	22	45	5	16	29	35	----	----	----	1.81	−0.3	15	5,922	sw.	27	w.	10	5	6	17	7.2	2.2	0.0
Toledo	628	208	243	29.35	30.05	−.02	36.6	+9.3	70	25	44	6	16	29	35	32	28	74	1.71	−0.3	15	8,648	sw.	37	sw.	10	9	8	11	6.1	2.5	0.0
Fort Wayne	856	113	124	29.10	30.04	------	38.6	+12.8	69	25	46	8	16	31	26	34	31	78	1.11	−1.2	9	6,080	sw.	29	w.	10	1	11	16	7.5	0.6	0.0
Detroit	730	218	258	29.22	30.03	−.03	33.8	+8.5	65	25	40	3	16	27	32	31	29	84	1.67	−0.5	13	5,539	sw.	30	w.	14	5	6	17	7.3	6.2	0.5
Upper Lake Region							26.0	+6.8										84	1.82	0.0										7.0		
Alpena	609	13	92	29.32	30.01	−.02	22.0	+4.0	50	23	30	−13	16	14	35	21	18	84	1.42	−0.3	13	6,609	w.	36	ne.	26	3	12	13	7.0	10.0	2.5
Escanaba	612	54	60	29.29	29.98	−.08	19.8	+4.4	46	20	29	−17	16	11	43	18	16	88	1.76	+0.3	17	5,545	s.	26	ne.	26	7	7	14	6.4	17.2	3.0
Grand Haven	632	54	89	29.28	29.98	−.07	30.6	+6.4	59	22	37	2	16	24	27	29	28	90	2.07	−0.1	16	7,351	s.	44	w.	9	4	4	20	8.0	6.1	0.0
Grand Rapids	707	70	87	29.20	30.02	−.03	32.9	+9.2	67	22	40	3	15	26	27	30	26	80	1.83	−0.4	13	3,734	sw.	26	nw.	9	3	9	16	7.3	5.9	0.0
Houghton	668	64	99	29.20	29.96	−.09	18.6	+4.9	68	19	28	−24	16	9	44	----	----	----	2.72	+0.9	15	6,362	e.	36	e.	25	3	10	15	7.4	17.9	14.3
Lansing	878	6	49	29.04	30.01	------	31.0	+8.1	66	22	38	1	15	24	29	29	28	93	1.41	−0.5	16	3,580	sw.	18	w.	14	6	8	14	7.0	7.8	T.
Ludington	637	60	66	29.26	29.98	------	28.8	+6.3	59	24	35	−1	16	23	25	27	25	86	2.51	+0.5	15	6,537	s.	35	w.	9	5	6	17	7.0	10.1	0.7
Marquette	734	77	111	29.14	29.97	−.08	21.8	+5.5	62	19	30	−13	15	14	29	20	17	84	1.56	−0.3	16	5,814	w.	38	s.	18	3	10	15	7.9	15.1	9.5
Port Huron	638	70	120	29.31	30.02	−.03	29.8	+7.1	60	22	36	−2	16	23	22	27	24	82	2.14	+0.2	13	6,761	s.	31	w.	14	4	11	13	6.5	5.4	0.3
Sault Sainte Marie	614	11	52	29.28	30.01	−.02	16.3	+3.7	45	20	25	−25	16	7	39	15	13	88	1.65	−0.3	14	4,676	se.	30	w.	14	11	5	12	5.9	16.9	15.0
Chicago	673	7	131	29.27	30.01	−.07	37.1	+10.8	67	21	44	1	15	30	27	33	29	73	1.42	−0.7	9	6,815	sw.	25	nw.	9	3	10	15	7.2	1.5	0.0
Green Bay	617	109	141	29.27	29.96	−.10	24.8	+7.4	60	21	33	−14	15	17	33	23	20	81	1.67	+0.1	12	6,327	s.	31	ne.	25	3	7	18	7.6	8.3	1.8
Milwaukee	681	125	221	29.22	29.98	−.08	32.3	+9.5	60	20	39	−7	15	26	24	30	27	82	1.28	−0.6	11	8,132	w.	31	w.	9	9	6	13	6.3	2.9	T.
Duluth	1,133	5	47	28.67	29.94	−.14	18.8	+7.4	51	19	26	−25	15	11	28	17	15	85	2.11	+1.1	15	8,951	ne.	50	nw.	9	7	6	15	6.8	18.9	12.1
North Dakota							22.0	+14.2										85	1.37	+0.8										6.1		
Moorhead	940	50	58	28.86	29.91	−.20	23.0	+14.9	52	19	31	−11	15	16	30	22	20	89	2.03	+1.3	14	5,360	s.	31	nw.	9	3	8	17	7.7	10.6	6.2
Bismarck	1,674	8	57	28.09	29.93	−.19	24.3	+14.0	57	18	34	−11	14	15	36	22	19	82	1.36	+0.9	10	5,325	nw.	30	nw.	13	8	15	5	5.1	15.8	10.6
Devils Lake	1,478	11	44	28.27	29.91	−.20	17.1	+12.0	48	20	25	−23	14	9	33	16	14	88	1.32	+0.8	10	6,327	nw.	36	n.	13	7	8	13	6.5	11.6	10.2
Ellendale	1,457	10	56	28.30	29.91	------	25.6	------	59	19	35	−16	15	16	39	----	----	----	0.92	+0.3	11	8,424	nw.	50	nw.	9	4	11	13	6.6	6.8	5.6
Grand Forks	833	12	67	----	----	----	18.2	------	47	18	26	−23	14	10	44	17	----	----	1.89	------	12	------	nw.	40	w.	9	16	11	1	----	17.9	11.7
Williston	1,878	41	48	27.89	29.93	−.18	23.8	+15.7	56	20	33	−15	14	15	32	22	18	80	1.24	+0.8	7	4,413	w.	33	nw.	12	12	8	8	4.7	12.7	8.5
Upper Mississippi Valley							36.3	+11.7										77	1.69	+0.1										6.5		
Minneapolis	918	102	208	28.90	29.92	------	27.4	+11.5	59	21	36	−12	15	19	25	----	----	----	2.66	+1.7	11	6,734	nw.	36	nw.	9	4	8	16	7.2	4.8	2.0
St. Paul	837	236	261	29.00	29.94	−.15	26.9	+11.1	58	20	35	−13	15	19	26	----	----	----	2.09	+1.2	12	6,973	se.	45	sw.	9	4	7	17	7.4	7.6	2.2
La Crosse	714	11	48	29.16	29.95	−.13	30.4	+11.2	64	21	39	−10	15	22	29	27	24	80	0.78	−0.3	11	2,976	s.	18	w.	9	5	11	12	6.9	3.5	0.3
Madison	974	70	78	28.90	29.90	−.08	30.0	+10.9	60	22	38	−11	15	22	24	28	25	82	0.78	−0.7	8	5,435	s.	26	w.	9	6	9	13	6.3	1.9	1.0
Wausau	1,247	4	64	28.59	29.98	------	22.8	------	58	21	32	−20	15	14	31	----	----	----	2.08	+0.9	12	3,687	w.	24	w.	9	8	2	18	7.1	10.1	3.2
Charles City	1,015	10	51	28.87	29.98	−.12	29.6	+12.5	61	21	38	−15	15	21	27	27	25	84	0.44	−0.7	9	4,188	se.	22	nw.	9	8	8	12	5.8	4.3	T.
Davenport	606	71	79	29.33	30.01	−.09	37.2	+12.3	69	19	45	−2	15	29	29	34	30	78	2.38	+0.8	8	6,873	sw.	38	nw.	9	5	11	12	6.5	0.6	0.0
Des Moines	861	5	99	29.06	29.99	−.12	38.2	+14.5	78	24	47	−10	15	29	36	34	29	72	0.50	−0.6	5	6,193	s.	31	nw.	9	7	9	12	6.4	4.5	0.0
Dubuque	700	81	96	29.22	29.99	−.10	33.7	+11.5	65	24	42	−5	15	26	31	31	29	83	1.19	−0.2	9	4,035	nw.	22	nw.	10	4	13	11	6.6	3.6	0.0
Keokuk	614	64	78	29.34	30.03	−.08	40.7	+12.4	78	24	50	0	15	32	38	36	30	70	1.01	−0.5	5	4,852	s.	25	nw.	9	6	12	10	6.4	1.0	0.0
Cairo	358	87	93	29.70	30.10	−.02	48.0	+9.5	74	25	56	20	16	40	28	43	37	71	2.53	−0.6	8	6,156	s.	32	n.	4	5	10	13	6.6	T.	0.0
Springfield, Ill	609	11	45	29.36	30.04	−.06	38.4	+12.5	71	24	47	0	15	30	31	34	31	78	2.10	+0.1	6	4,455	s.	22	w.	9	10	9	9	5.2	0.6	0.0
Hannibal	534	74	109	29.45	30.04	−.07	40.4	+10.9	78	24	48	6	15	33	27	37	33	79	2.76	+0.4	7	8,236	s.	31	se.	25	8	7	16	6.7	1.8	0.0
St. Louis	568	265	303	29.44	30.05	−.06	42.0	+12.3	79	24	51	6	15	33	36	----	----	----	1.73	−0.1	6	5,782	sw.	29	sw.	24	7	9	12	6.1	1.8	0.0
Missouri Valley							45.3	+10.8	80	24	54	12	16	37	32	39	33	68	2.35	−0.2	4	8,273	sw.	35	sw.	21	9	9	10	5.7	4.2	0.0
							41.0	+15.1										69	0.77	−0.4										5.2		
Columbia, Mo	784	6	84	29.18	30.03	−.08	44.2	+12.5	81	24	53	6	15	35	39	----	----	----	1.82	−0.2	4	5,238	s.	27	sw.	24	7	10	11	5.9	3.4	0.0
Kansas City	963	161	181	28.96	30.02	−.09	46.2	+15.0	81	24	55	5	15	37	34	40	34	66	0.80	−1.0	5	7,067	s.	27	nw.	9	12	12	4	4.3	1.2	0.0
St. Joseph	967	11	49	28.94	30.00	------	44.3	------	83	24	54	3	15	34	34	38	32	66	0.83	−0.6	4	5,576	sw.	28	nw.	9	13	10	5	4.0	2.5	0.0
Springfield, Mo	1,324	98	104	28.63	30.06	−.05	46.8	+11.6	76	24	56	21	15	38	30	41	36	71	1.59	−0.8	4	6,781	s.	29	sw.	24	13	7	8	4.5	T.	0.0
Iola	984	11	50	28.96	30.02	−.08	47.1	+13.9	82	24	58	18	15	36	42	----	----	----	0.05	−1.6	1	4,645	s.	21	sw.	24	12	9	7	4.5	T.	0.0
Topeka	987	92	107	----	----	----	46.6	+15.6	83	24	57	7	15	36	36	----	----	----	0.60	−0.9	3	6,600	sw.	31	sw.	21	14	9	5	4.0	0.3	0.0
Lincoln	1,189	11	81	28.69	29.98	−.12	41.6	+15.5	70	18	52	2	15	31	34	36	30	70	0.31	−0.6	4	5,997	s.	32	nw.	9	7	13	8	5.7	1.5	0.0
Omaha	1,105	115	122	28.78	29.99	−.12	40.8	+15.3	70	18	50	4	15	32	33	35	29	67	0.21	−0.7	3	4,895	nw.	29	nw.	9	9	14	5	4.8	1.6	0.0
Valentine	2,598	47	54	27.21	29.98	−.11	37.6	+16.2	74	20	50	8	27	26	42	31	25	69	0.70	+0.2	6	5,063	w.	28	nw.	9	4	15	9	5.8	7.0	4.2
Sioux City	1,135	94	164	28.74	29.98	−.14	36.4	+15.4	69	18	46	−3	14	27	32	32	27	72	0.28	−0.5	3	7,523	nw.	42	nw.	9	3	15	10	6.4	3.4	T.
Huron	1,306	59	74	28.52	29.95	−.17	32.2	+17.9	70	18	43	−5	15	22	40	28	24	77	1.24	+0.7	4	5,751	w.	34	w.	9	4	15	9	6.0	2.9	9.6
Pierre	1,572	70	75	28.25	29.96	−.15	35.0	+16.4	75	18	46	3	14	24	41	29	22	66	1.32	+0.9	4	5,329	nw.	34	nw.	9	8	13	7	5.0	10.7	10.1
Yankton	1,233	49	57	28.61	29.969	−.16	36.4	+15.5	69	18	47	0	15	26	37	----	----	----	0.24	−0.6	3	5,023	nw.	30	nw.	9	5	10	13	6.5	3.0	T.

TABLE 1.—*Climatological data for Weather Bureau stations, February, 1930*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	°F.		°F.	° F.		°F.	° F.	° F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope							34.4	+12.6										68	0.46	−0.2										6.1		
Billings	3,140	5					36.8		69	18	48	7	28	25	39				0.50		4		nw.				6	12	10		2.0	1.5
Havre	2,505	11	44	27.24	29.93	−0.14	33.3	+19.7	62	18	43	−1	14	24	51	29	23	71	0.27	−0.2	5	5,636	sw.	27	sw.	10	3	11	14	6.8	2.4	0.5
Helena	4,110	87	112	25.72	29.98	−.13	35.8	+12.8	64	18	44	11	28	28	27	30	22	58	0.25	−0.4	7	5,180	sw.	44	sw.	15	2	11	15	7.6	2.8	0.4
Kalispell	2,973	48	56	26.87	29.98	−.10	32.4	+9.1	60	18	40	3	14	25	26	29	23	69	0.62	−0.5	8	3,160	nw.	26	sw.	18	5	15	8	5.9	3.0	T.
Miles City	2,371	48	55	27.38	29.99	−.10	33.4	+16.6	65	18	44	5	28	23	37	29	24	73	0.36	−0.1	5	3,485	s.	29	nw.	12	4	13	11	6.5	0.4	0.4
Rapid City	3,259	50	58	26.52	30.00	−.08	37.8	+14.4	74	18	49	7	15	27	47	31	23	60	0.18	−0.3	3	4,564	w.	28	nw.	11	7	12	9	5.9	1.7	1.7
Cheyenne	6,088	84	101	23.92	29.99	−.04	34.5	+7.2	61	18	44	8	28	25	30	29	23	64	1.03	+0.4	8	8,962	w.	48	w.	1	5	12	11	6.3	11.6	0.9
Lander	5,372	60	68	24.56	30.00	−.08	34.2	+11.7	59	18	45	11	28	23	36	30	25	73	0.46	−0.2	3	3,056	w.	46	w.	8	11	13	4	4.8	4.5	4.0
Sheridan	3,790	10	47	26.01	29.98		33.6		69	18	44	2	15	23	48	29	23	68	0.48	−0.2	7	2,908	nw.	18	nw.	25	4	15	9	6.0	5.3	2.0
Yellowstone Park	6,241	11	48		30.07	−.03	27.6	+8.0	48	19	35	2	28	20	26			73	0.69	−0.6	17	5,992	sw.	32	sw.	8	3	7	18		12.4	4.8
North Platte	2,821	11	51	27.01	29.98	−.09	40.3	+13.7	74	20	53	15	1	27	42	33	27	68	0.24	−0.3	2	4,276	w.	22	nw.	21	11	10	7	4.9	0.2	0.0
Middle Slope							46.2	+12.4										59	0.59	−0.3										4.2		
Denver	5,292	106	113	24.66	29.96	−.05	42.3	+9.6	71	18	54	19	15	31	40	33	22	51	0.16	−0.4	3	4,665	s.	26	nw.	11	8	14	6	4.7	2.2	0.0
Pueblo	4,685	80	86	25.21	29.93	−.07	43.2	+10.3	72	23	59	16	1	27	48	32	18	44	0.06	−0.4	2	4,301	nw.	34	nw.	11	18	8	2	3.4	0.5	0.0
Concordia	1,392	50	58	28.52	30.01	−.08	45.2	+15.4	77	19	56	10	15	34	34	38	30	63	0.14	−0.7	4	5,286	s.	27	s.	21	7	15	6	5.2	T.	0.0
Dodge City	2,509	11	51	27.38	30.02	−.04	47.2	+14.0	80	23	62	22	10	32	42	37	28	58	0.04	−0.7	3	5,344	nw.	27	se.	27	19	6	3	2.9	T.	0.0
Wichita	1,358	139	158	28.54	29.99	−.09	48.6	+14.2	82	23	59	20	15	38	33	41	35	64	T.	−1.2	0	8,341	s.	40	s.	21	12	11	5	4.2	T.	0.0
Broken Arrow	765	11	56	29.20	30.03		49.4		76	23	59	29	16	40	33				2.46	+1.1	4	8,186	s.	38	ne.	9	9	10	9	5.4	0.0	0.0
Oklahoma City	1,214	10	47	28.72	30.02	−.05	50.8	+11.2	80	23	62	29	15	40	35	44	39	72	1.29	+0.2	5	6,523	s.	30	n.	9	13	9	6	3.9	0.0	0.0
Southern Slope							54.5	+8.6										47	0.02	−0.7										2.6		
Abilene	1,738	10	52	28.19	30.00	−.05	57.5	+10.3	87	23	72	29	10	43	44	45	34	50	0.06	−1.0	1	6,300	s.	27	s.	21	15	9	4	3.3	0.0	0.0
Amarillo	3,676	10	49	26.23	29.98	−.04	49.5	+11.4	77	23	64	27	13	35	42	37	25	46	0.00	−0.7	0	5,591	sw.	25	s.	27	20	6	2	2.1	0.0	0.0
Del Rio	944	64	71	29.01	30.00	.00	61.1	+5.1	85	12	74	37	5	48	42	51	41	56	0.01	−0.5	1	4,952	se.	26	nw.	25	14	12	3	3.3	0.0	0.0
Roswell	3,566	75	85	26.36	29.98	.00	49.9	+7.4	81	23	68	21	26	32	54	37	20	36	T.	−0.6	0	4,548	s.	34	nw.	26	21	7	0	1.8	0.0	0.0
Southern Plateau							50.0	+5.2										45	0.50	−0.1										2.0		
El Paso	3,778	152	175	26.20	30.00	+.05	53.2	+4.2	77	19	67	28	26	40	36	40	24	37	0.16	−0.2	2	6,044	nw.	34	ne.	4	24	4	0	1.6	0.0	0.0
Santa Fe	7,013	38	53	23.23	30.02	+.04	38.6	+5.5	61	18	50	13	4	27	30	30	20	51	0.49	−0.3	5	3,874	n.	19	n.	3	18	7	3	2.8	2.6	T.
Flagstaff	6,907	10	59	23.35	30.02	+.02	35.0	+4.2	62	18	50	6	25	20	41	28		62	1.06		5	5,025	w.	44	ne.	3	16	9	3		5.2	2.0
Phoenix	1,108	10	107	28.83	29.99	.00	60.4	+5.3	87	17	76	36	26	45	40	46	32	40	0.19	−0.6	1	2,945	e.	27	n.	3	23	1	4	2.0	0.0	0.0
Yuma	141	9	54	29.85	30.00	.00	63.0	+4.4	88	17	78	37	25	48	42	49	32	36	0.01	−0.4	1	3,087	n.	22	w.	26	22	6	0	1.5	0.0	0.0
Independence	3,957	6	27	26.00	30.06	.00	50.0	+7.8	76	16	64	23	28	35	37	38			1.66	+0.9	2		nw.				19	4	5		0.0	0.0
Middle Plateau							37.6	+4.3										64	0.84	−0.2										5.1		
Reno	4,532	74	81	25.51	30.09	+.01	42.4	+6.8	71	17	55	20	27	30	40	36	29	62	0.41	−0.8	5	3,370	w.	34	se.	19	8	15	5	4.8	1.1	T.
Tonopah	6,090	12	20				40.9		66	17	50	16	24	32	27	31	19	44	0.12		2		nw.									
Winnemucca	4,344	18	56	25.67	30.12	+.03	37.8	+4.3	65	17	49	11	1	27	36	33	28	72	0.61	−0.3	8	3,907	sw.	30	w.	20	8	16	4	4.7	0.8	T.
Modena	5,473	10	43	24.64	30.05	+.01	36.4	+5.4	63	17	50	2	28	23	38	31	24	66	0.56	−0.4	6	5,599	w.	36	s.	20	10	9	9	4.7	4.0	T.
Salt Lake City	4,360	163	203	25.66	30.09	+.01	39.9	+6.1	65	18	48	23	4	32	27	35	28	64	2.15	+0.6	7	3,553	s.	29	se.	22	6	9	13	6.5	20.6	6.1
Grand Junction	4,602	60	68	25.44	30.10	+.06	31.6	−1.3	60	22	43	0	4	20	31	27	22	73	0.45	−0.1	8	2,752	nw.	26	se.	27	11	9	8	4.9	4.5	0.0
Northern Plateau							39.7	+6.7										71	1.55	+0.1										7.6		
Baker	3,471	48	53	26.46	30.10	−.02	34.6	+5.6	55	18	42	17	9	28	24	32	28	76	0.74	−0.5	13	3,219	se.	18	sw.	20	1	6	21	8.5	5.5	T.
Boise	2,739	78	86	27.22	30.12	.00	40.4	+5.6	66	17	48	22	27	33	29	36	31	73	2.63	+1.2	12	2,715	se.	22	se.	22	1	6	21	8.1	8.1	1.3
Lewiston	757	40	48	29.22	30.04	−.07	43.0	+6.0	62	19	50	28	9	36	21				1.37	+0.1	12	2,529	e.	27	nw.	8	3	10	15	7.5	6.3	0.0
Pocatello	4,477	60	68	25.49	30.08	−.02	37.2	+8.3	61	18	44	19	28	30	23	33	27	68	1.19	−0.1	10	7,312	se.	30	sw.	11	2	14	12	6.6	7.0	6.0
Spokane	1,929	101	110	27.95	30.03	−.06	38.1	+6.8	60	18	45	14	14	31	20	35	30	73	1.52	−0.2	9	3,924	sw.	26	sw.	20	5	10	13	6.8	2.6	0.0
Walla Walla	901	57	65	28.95	30.03	−.08	44.8	+7.7	69	17	52	28	9	38	26	40	34	66	1.87	+0.1	13	3,246	s.	22	w.	22	0	8	20	8.2	1.9	0.0
North Pacific Coast Region							44.4	+3.5										81	5.01	+0.4										8.0		
North Head	211	11	56	29.78	30.01	−.05	44.4	+1.4	58	17	49	33	8	40	15	43	40	85	6.48	−1.0	21	11,148	s.	72	s.	20	4	7	17	7.6	0.0	0.0
Port Angeles	29	8	53		30.02		40.9		59	17	47	29	9	34	19				4.25	+1.0	17	3,617	sw.	37	w.	10	2	9	17		1.2	0.0
Seattle	125	215	250	29.86	29.99	−.07	44.3	+3.2	63	17	50	30	28	39	18	42	38	80	3.82	−0.1	18	6,212	s.	47	s.	20	2	5	21	8.1	2.3	0.0
Tacoma	194	172	201	29.82	30.03	−.03	44.6	+4.0	67	17	51	28	9	38	21				3.96	−0.7	20	5,349	s.	42	s.	20	2	8	18	7.6	2.0	0.0
Tatoosh Island	86	9	53	29.84	29.94	−.06	43.3	+2.3	53	17	47	34	13	40	11	42	41	91	15.80	+6.4	24	12,516	e.	53	s.	4	4	3	21	7.6	0.0	0.0
Yakima	1,076	58	67	28.86	30.03		39.8	+5.3	64	17	49	23	1	31	29	35	30	70	1.19	+0.2	7	2,528	nw.	30	w.	2	3	11	14	7.0	2.6	0.0
Medford	1,329	29	58	28.55	30.08		44.8		68	14	53	29	28	36	31	43	41	85	1.59	−0.8	13		nw.	40	se.	22	1	6	21	8.6	1.3	0.0
Portland, Oreg.	153	68	106	29.88	30.04	−.04	46.3	+4.2	63	17	53	31	28	40	21	44	40	78	5.03	−0.3	17	3,702	se.	27	s.	20	0	5	23	8.8	T.	0.0
Roseburg	510	75	99	29.52	30.08	−.02	47.8	+4.4	68	17	55	30	28	40	24	45	41	78	2.96	−1.5	20	2,051	s.	22	s.	21	0	8	20	8.5	0.7	0.0
Middle Pacific Coast Region							53.6	+3.7										78	2.95	−1.0										5.0		
Eureka	62	73	89	30.06	30.13	+.02	50.5	+3.3	85	17	57	33	28	44	36	47	45	84	4.92	−1.6	17	3,775	se.	32	se.	21	4	7	17	7.1	0.0	0.0
Red Bluff	330	5	58	29.72	30.09	−.02	53.6	+4.2	80	15	64	32	27	43	35	49	45	74	3.42	−0.5	11	3,385	nw.	30	se.	19	10	10	8	5.4	0.0	0.0
Sacramento	69	106	117	30.02	30.09	.00	53.6	+3.5	76	14	63	34	27	44	29	50	47	79	1.62	−1.4	8	4,297	se.	37	se.	22	20	6	2	2.5	0.0	0.0
SanFrancisco	155	208	243	29.92	30.09	−.01	56.5	+4.3	78	14	63	43	27	50	23	52	48	76	2.94	−0.9	8	3,426	w.	28	n.	24	11	12	5	4.6	0.0	0.0
San Jose	141	12	110	29.95	30.10		54.0	+3.4	81	17	65	33	27	43	36				1.86	−0.5	7	3,389	se.	35	se.	22	11	7	10	5.2	0.0	0.0
South Pacific Coast Region							57.7	+3.8										69	1.00	−1.2										3.7		
Fresno	327	89	98	29.74	30.10	+.02	55.8	+4.7	84	17	67	36	24	45	34	50	43	66	1.89	+0.5	7	2,780	nw.	30	nw.	23	19	6	3	3.1	0.0	0.0
Los Angeles	338	159	191	29.69	30.06	.00	59.4	+3.9	89	17	63	43	28	50	31	51	44	66	0.45	−2.6	3	2,942	sw.	23	nw.	24	19	6	3	3.0	0.0	0.0
San Diego	87	62	70	29.96	30.06	.00	57.9	+2.8	84	17	65	44	28	51	28	52	48	76	0.66	−1.4	4	3,280	nw.	19	s.	22	8	13	7	5.1	0.0	0.0
West Indies																																
San Juan, P. R	82	9	54	29.92	30.01		74.6	−0.3	87	18	80	66	3	69	17				2.36	−0.1	16	5,702	e.	25	e.	15	8	18	2	5.0	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, February, 1930*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F.*		°*F.*	° *F.*		°*F.*	° *F.*	° *F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Panama Canal																																
Balboa Heights	118	7	97	[1] 29.78	[1] 29.87	+0.01	79.7	−0.6	92	12	89	69	4	71	22	----	----	[2] 75	0.85	+0.1	4	5,965	n.	24	n.	8	10	15	3	4.7	0.0	0.0
Cristobal	38	7	97	[1] 29.86	[1] 29.89	.00	81.2	+0.4	86	27	85	73	24	77	12	73	71	[2] 73	0.75	−0.8	9	8,888	n.	24	n.	28	8	18	2	4.4	0.0	0.0
Alaska																																
Fairbanks	455	11	44	[1] 29.25	[1] 29.84	----	−21.1	----	32	27	−11	−51	10	−31	41	−23	−27	77	0.36	----	4	----	n.	----	----	----	14	7	7	4.5	5.3	15.8
Juneau	80	11	50	[1] 29.47	[1] 29.56	----	29.2	----	45	4	33	2	12	25	15	28	25	83	8.59	----	23	5,088	se.	29	e.	18	2	2	24	8.6	64.5	15.8
Hawaiian Islands																																
Honolulu	38	86	100	[1] 30.00	[1] 30.04	----	72.6	+1.8	81	25	78	65	7	68	14	66	64	76	1.21	−2.5	8	4,181	ne.	31	e.	27	15	9	4	4.1	0.0	0.0

[1] Pressure not reduced to mean of 24 hours.

[2] Observations taken hourly.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, February, 1930*

Stations	Altitude above mean sea level Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*
Cape Race, N. F	99												
Sydney, C. B. I	48	29.90	29.95	+0.03	20.2	+0.9	30.4	10.0	48	−10	4.20	+0.11	32.0
Halifax, N. S	88	29.88	29.99	+.04	23.8	+1.4	32.9	14.7	47	−2	3.46	−1.70	20.5
Yarmouth, N. S	65	29.87	29.94	−.05	27.2	+1.4	35.3	19.0	47	5	4.77	+0.60	35.2
Charlottetown, P. E. I	38	29.86	29.90	−.05	18.8	+1.2	27.5	10.2	47	−6	4.72	+1.66	43.2
Chatham, N. B	28												
Father Point, Que	20	29.94	29.97	−.01	13.2	+1.7	22.0	4.5	40	−17	0.56	−1.65	5.6
Quebec, Que	296	29.69	30.03	+.04	13.5	+1.7	21.5	5.6	47	−18	1.86	−1.41	18.0
Doucet, Que	1,236				3.4		20.3	−13.4	45	−54	2.46		20.0
Montreal, Que	187	29.81	30.03	+.01	17.7	+3.2	25.9	9.5	46	−14	1.34	−1.73	11.4
Ottawa, Ont	236	29.78	30.07	+.05	17.3	+5.6	27.5	7.0	54	−19	0.84	−1.85	7.4
Kingston, Ont	285	29.73	30.07	+.03	21.2	+3.4	29.1	13.3	48	−14	0.80	−1.74	4.7
Toronto, Ont	379	29.62	30.05	+.01	26.8	+5.3	34.1	19.5	55	−6	2.28	−0.33	11.3
Cochrane, Ont	930				6.0		17.0	−4.9	52	−34	2.17		21.7
White River, Ont	1,244	28.57	29.95	−.07	7.5	+7.3	22.1	−7.1	52	−50	1.06	−0.46	9.6
London, Ont	808				27.4		35.3	19.6	58	−6	2.81		17.5
Southampton, Ont	656	29.28	30.02	.00	22.6	+2.7	30.8	14.5	56	−20	3.19	+0.29	22.7
Parry Sound, Ont	688	29.30	30.03	+.02	17.4	+3.1	26.1	8.8	50	−28	2.22	−0.70	12.8
Port Arthur, Ont	644	29.23	29.96	−.09	16.4	+10.0	24.7	8.1	50	−22	0.85	−0.05	6.1
Winnipeg, Man	760												
Minnedosa, Man	1,690	28.02	29.92	−.17	11.8	+14.5	20.5	3.0	43	−30	1.20	+0.59	11.8
Le Pas, Man	860				2.5		11.6	−6.5	39	−41	1.13		11.3
Qu'Appelle, Sask	2,115	27.56	29.89	−.19	16.4	+17.0	24.0	8.8	47	−28	0.48	−0.25	4.2
Moose Jaw, Sask	1,759				21.1		30.6	11.6	50	−24	0.87		8.4
Swift Current, Sask	2,392	27.24	29.82	−.25	26.4	+18.4	35.6	17.2	52	−18	0.14	+0.60	1.4
Medicine Hat, Alb	2,144												
Calgary, Alb	3,428												
Banff, Alb	4,521												
Prince Albert, Sask	1,450	28.30	29.97	−.12				−0.1	47	−40	0.53	−0.16	5.3
Battleford, Sask	1,592	28.09	29.90	−.19	14.5	+14.4	24.6	4.3	47	−34	0.64	+0.27	4.4
Edmonton, Alb	2,150												
Kamloops, B. C	1,262												
Victoria, B. C	230	29.71	29.97	−.03	42.1	+2.6	46.8	37.5	54	32	5.17	+1.07	1.0
Barkerville, B. C	4,180												
Estevan Point, B. C	20												
Prince Rupert, B. C	170												
Hamilton, Ber	151												
LATE REPORTS, JANUARY, 1930													
Winnipeg, Man	760	29.36	30.28	+0.17	−7.3	−0.5	0.0	−14.7	23	−35	0.29	−0.59	2.9
Medicine Hat, Alb	2,144	27.81	30.22	+.15	3.3	−2.2	11.7	−5.1	24	−36	0.03	−0.54	0.3
Calgary, Alb	3,428	26.47	30.29	+.26	3.3	−5.1	12.3	−5.6	42	−38	0.34	−0.19	3.4
Banff, Alb	4,521	25.39	30.33	+.33	−4.0	−16.1	6.0	−13.9	33	−51	1.13	−0.06	11.3
Edmonton, Alb	2,150	27.82	30.28	+.25	−1.8	−3.6	5.1	−8.6	25	−42	0.57	−0.11	5.7
Kamloops, B. C	1,262	29.02	30.41	+.45	2.7	−20.3	8.4	−3.0	43	−16	0.20	−0.62	2.0
Estevan Point, B. C	20				34.0		41.2	26.8	49	15	2.96		1.6
Prince Rupert, B. C	170				29.0		34.2	23.9	44	12	2.39		11.4

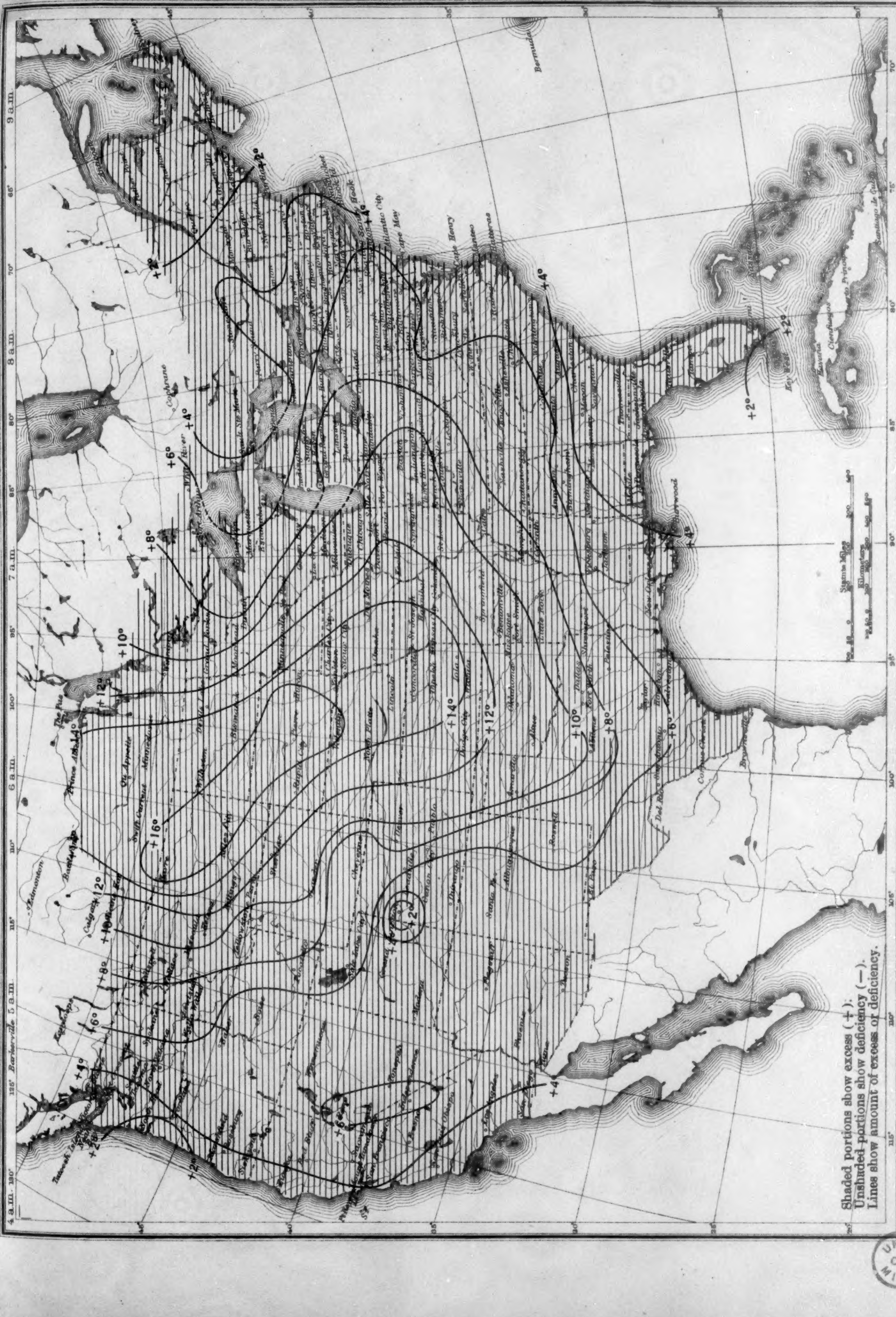
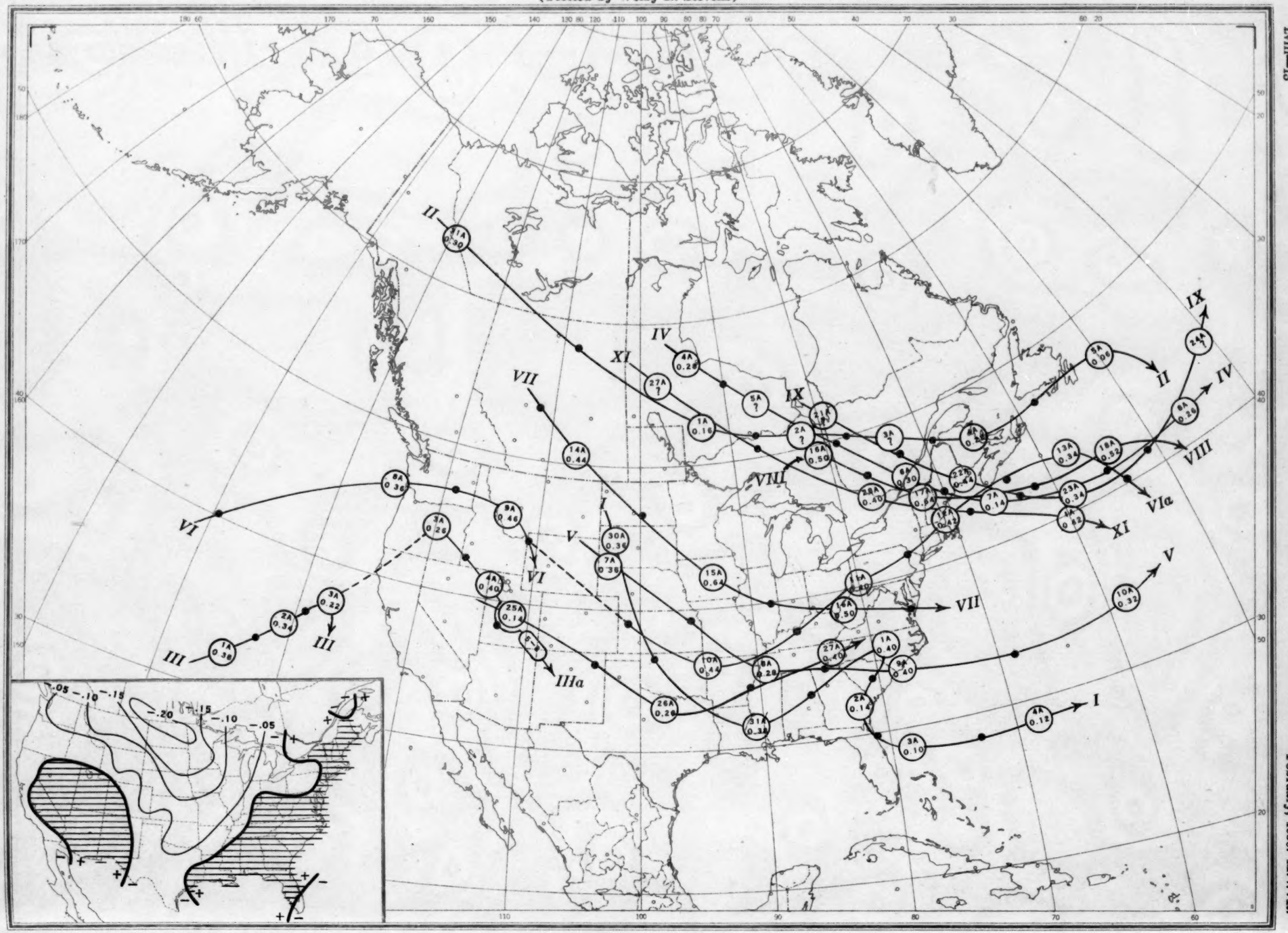


Chart I. Departure (°F.) of the Mean Temperature from the Normal, February, 1930

Chart II. Tracks of Centers of Anticyclones, February, 1930. (Inset) **Departure of Monthly Mean Pressure from Normal**

(Plotted by Welby R. Stevens)



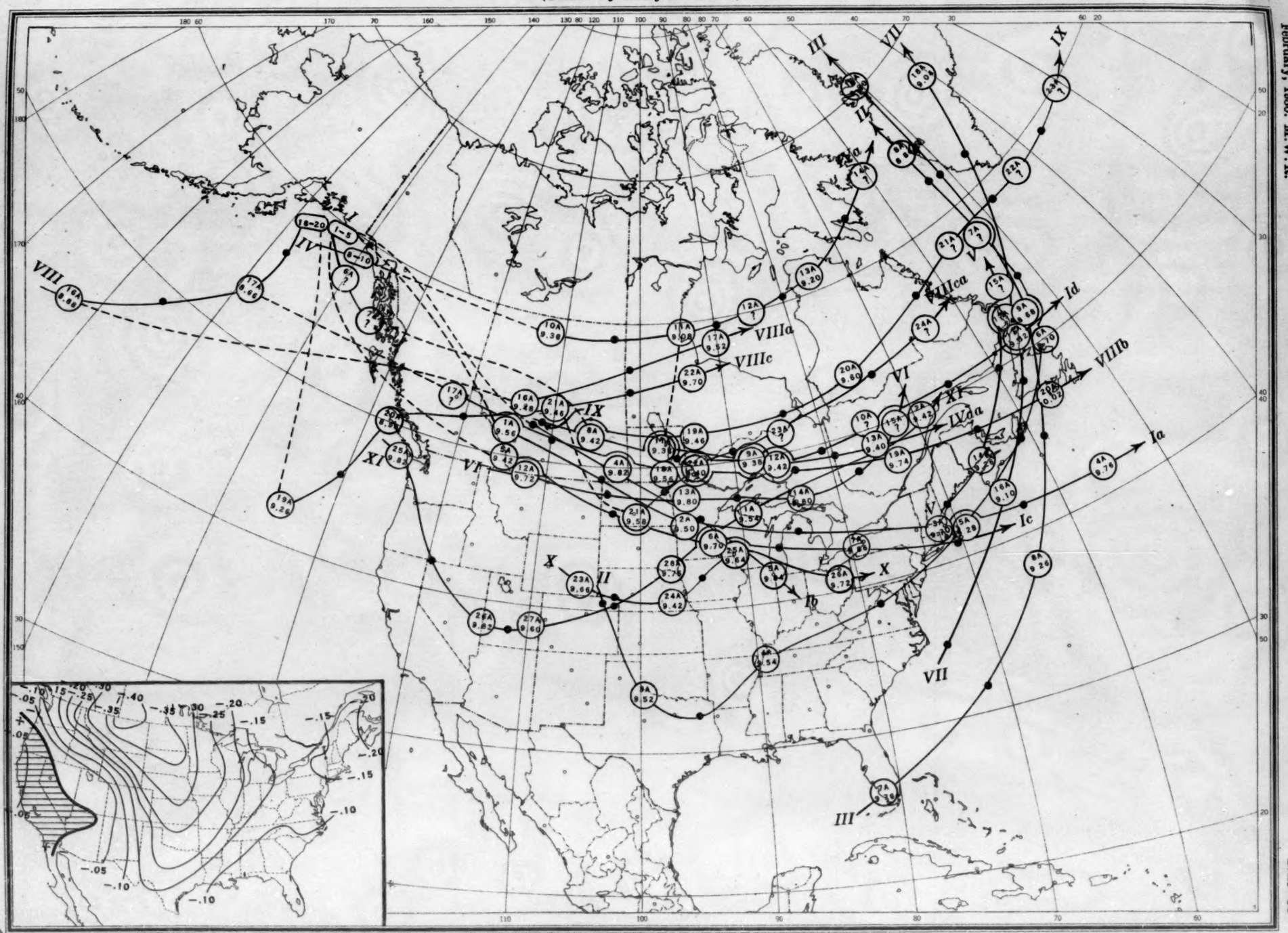
Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, February, 1930. (Inset) **Change in Mean Pressure from Preceding Month**

Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, February, 1930. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by Welby R. Stevens)



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Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, February, 1930

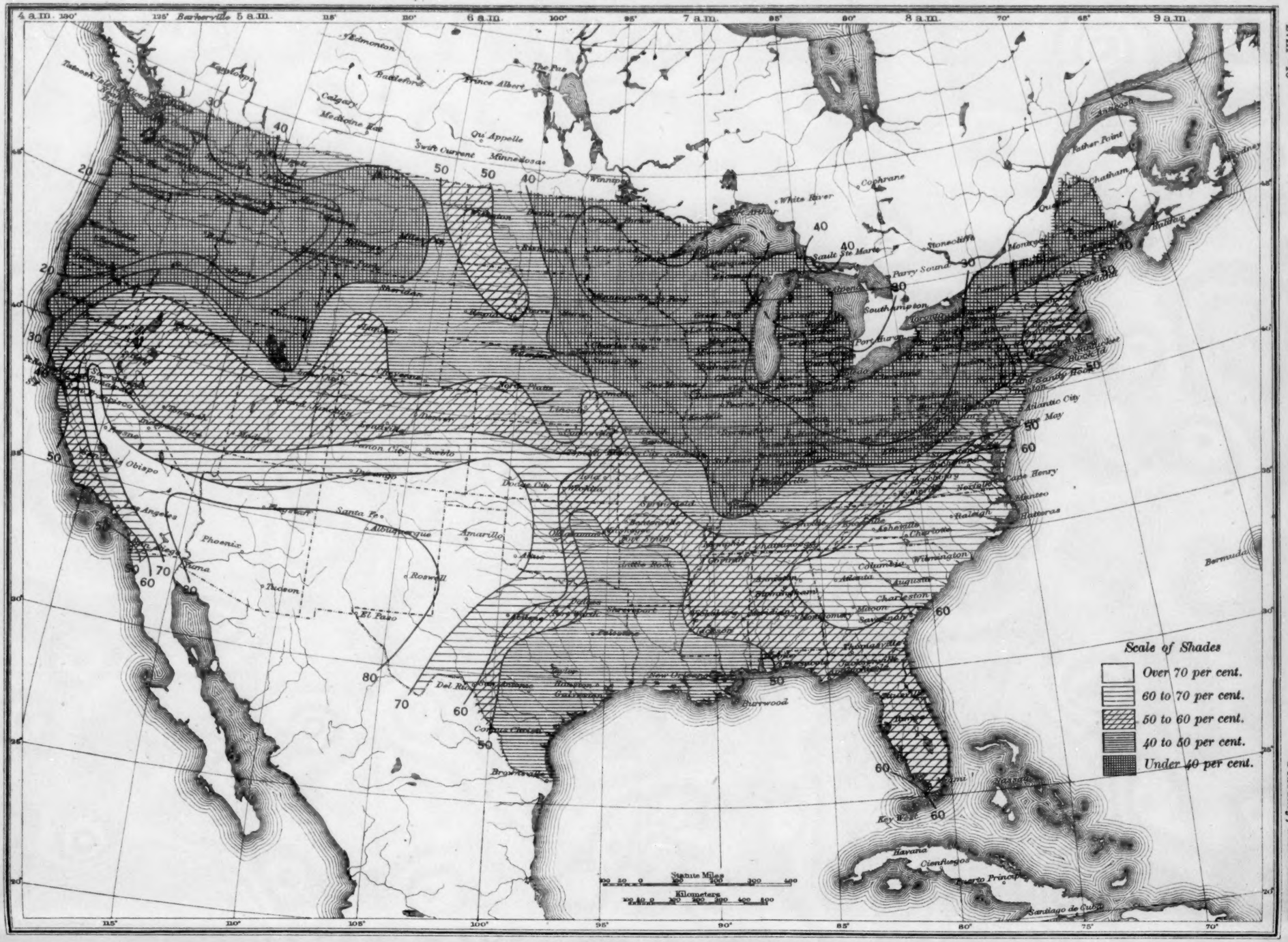

Chart V. Total Precipitation, Inches, February, 1930. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, February, 1930. (Inset) Departure of Precipitation from Normal

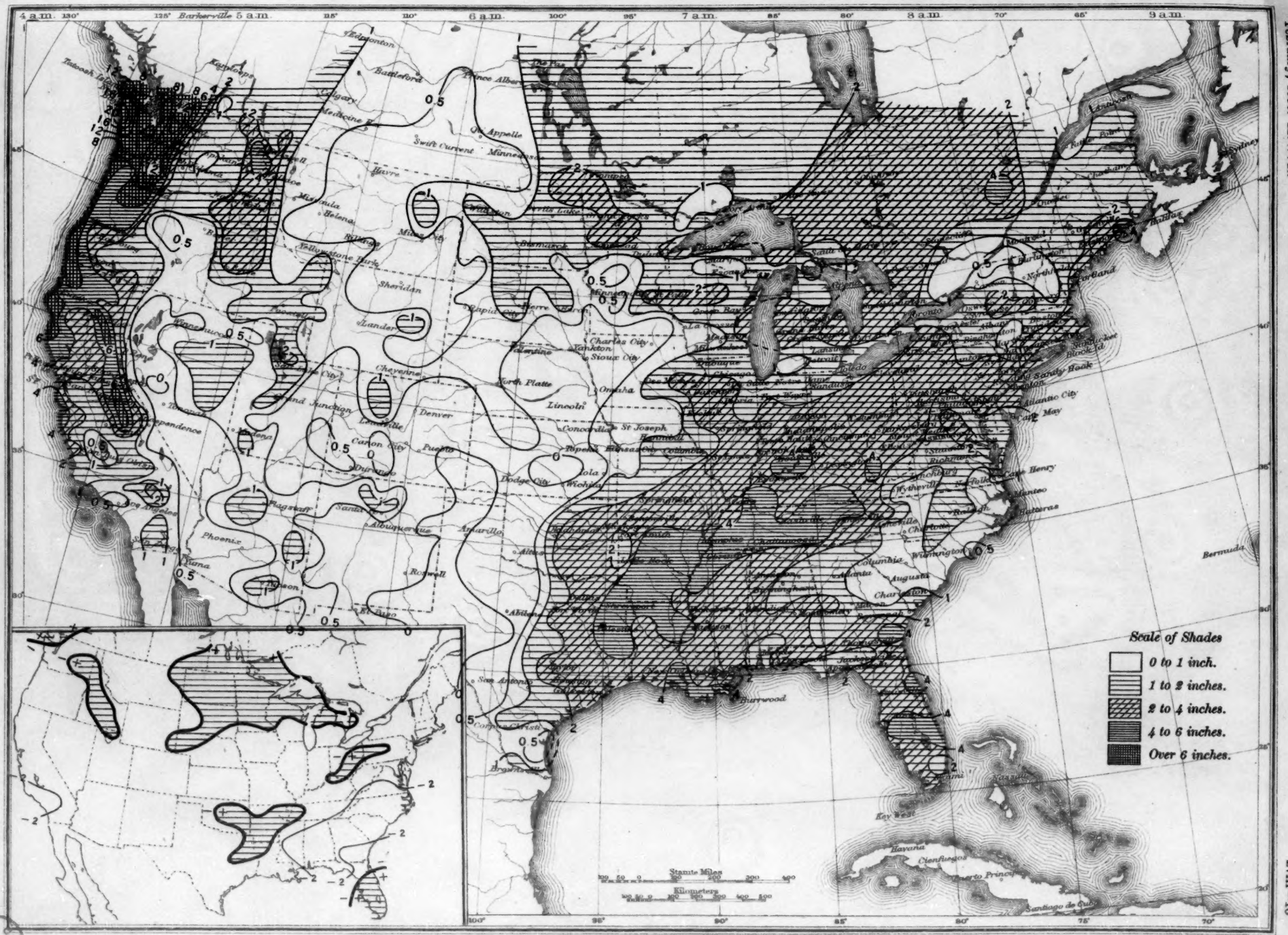

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, February, 1930

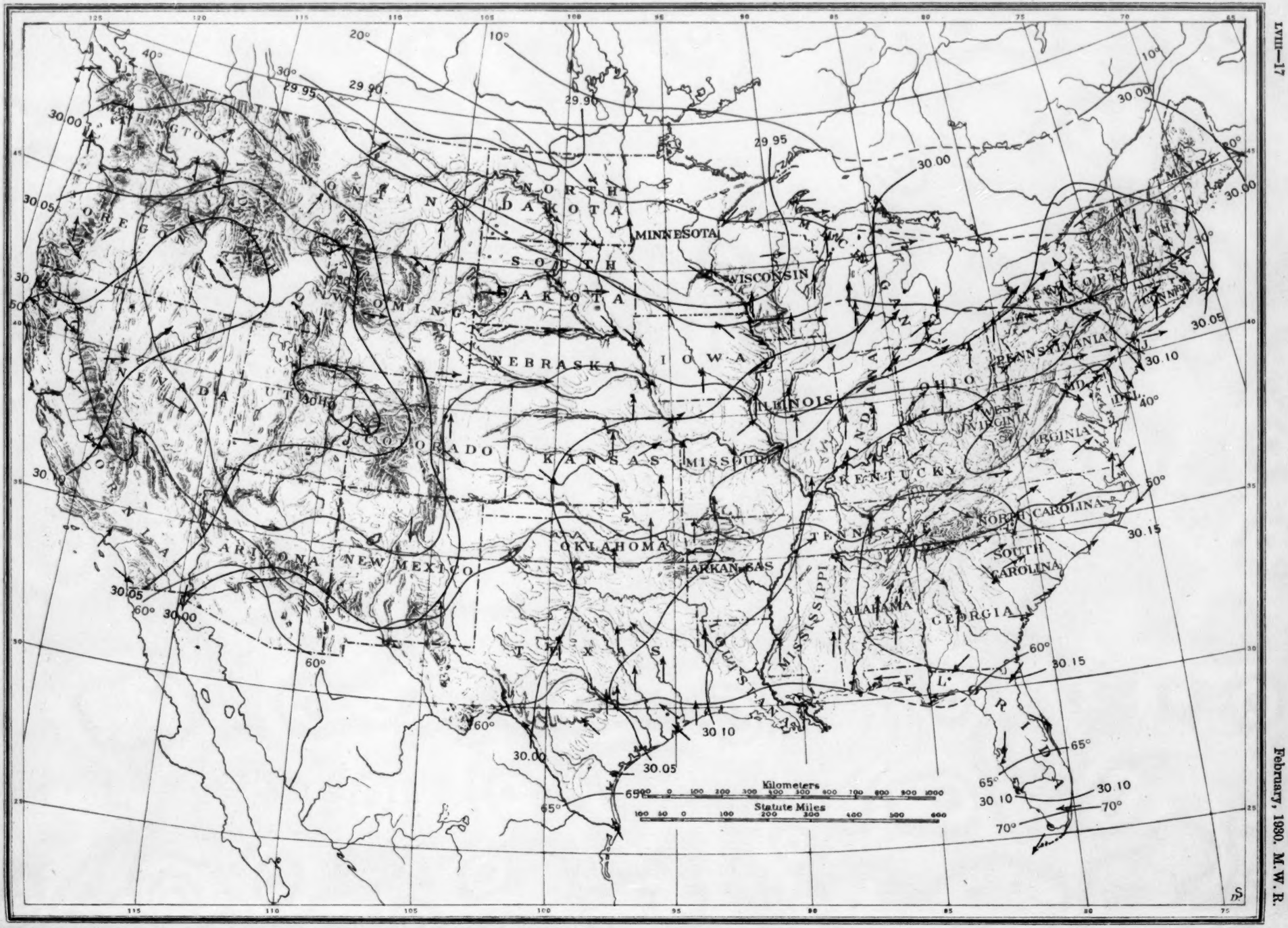

Chart VII. Total Snowfall, Inches, February, 1930. (Inset) Depth of Snow on Ground at end of Month

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Chart VIII.—Weather Map of North Atlantic Ocean, February 1, 1930

Chart VIII. Weather Map of North Atlantic Ocean, February 1, 1930

(Plotted by F. A. Young)

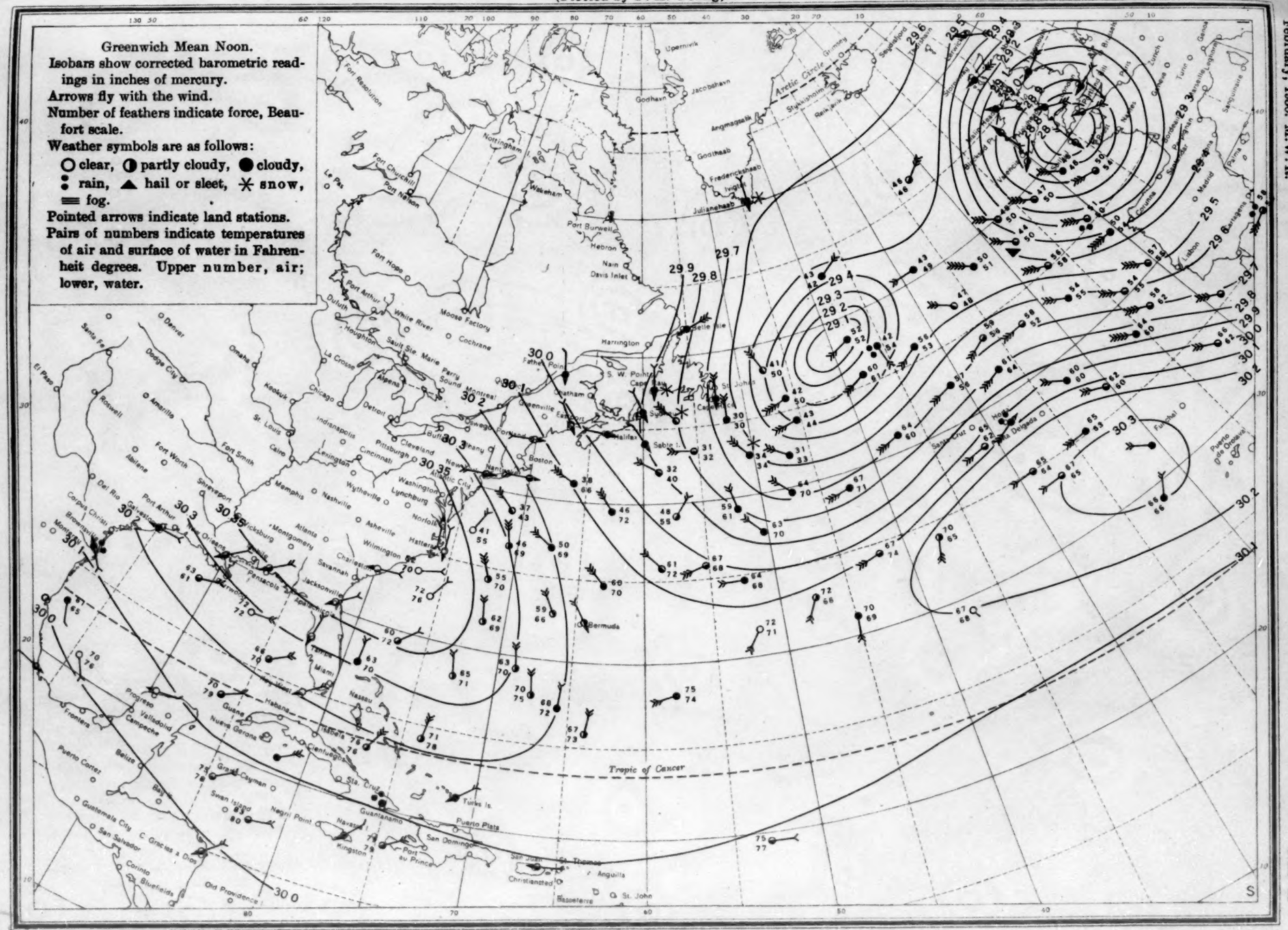

Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy,
rain, hail or sleet, snow,
fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.
Tropic of Cancer
Arctic Circle

Chart IX. Weather Map of North Atlantic Ocean, February 5, 1930

(Plotted by F. A. Young)

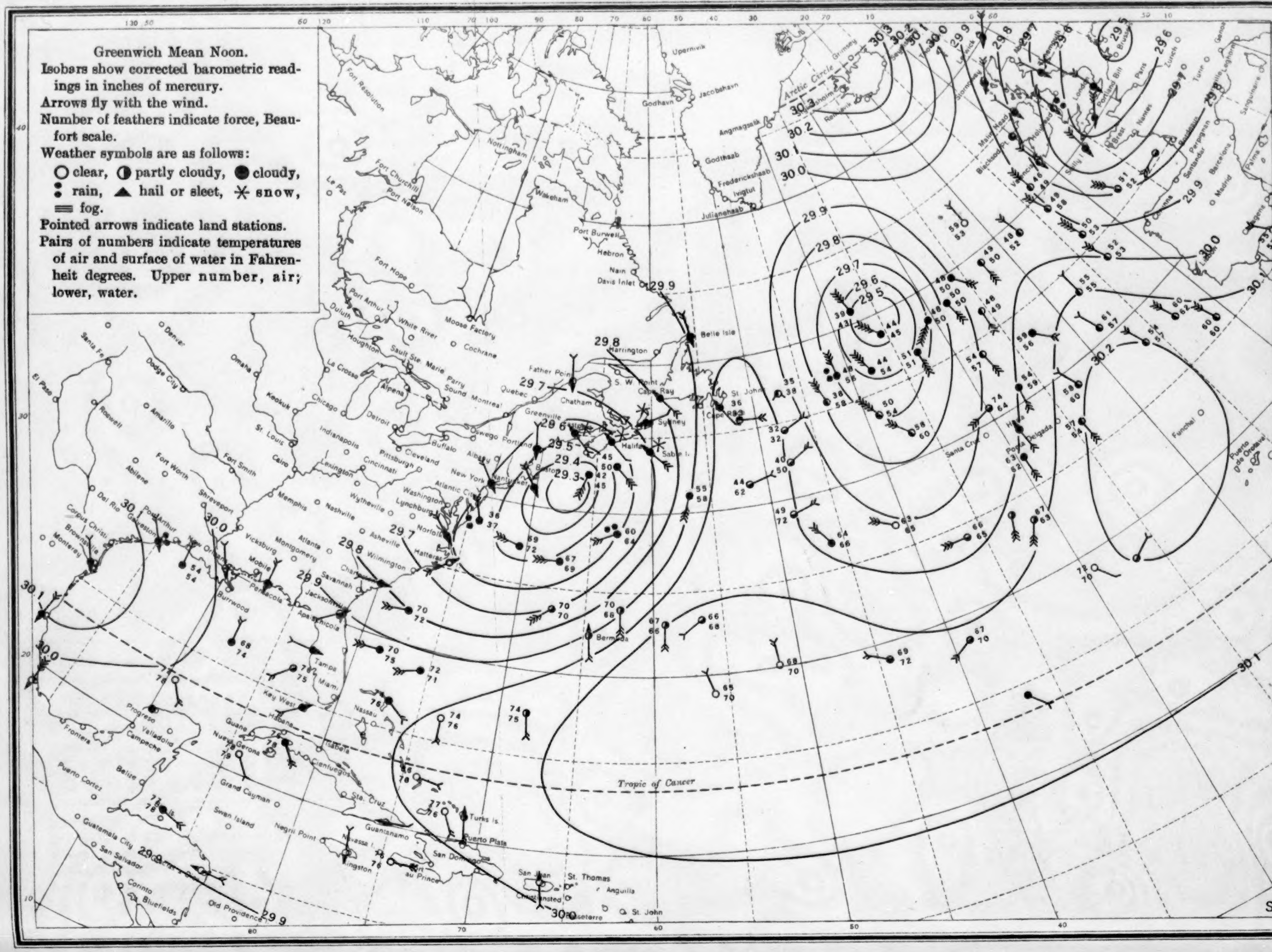


Chart X. Weather Map of North Atlantic Ocean, February 6, 1930

(Plotted by F. A. Young)

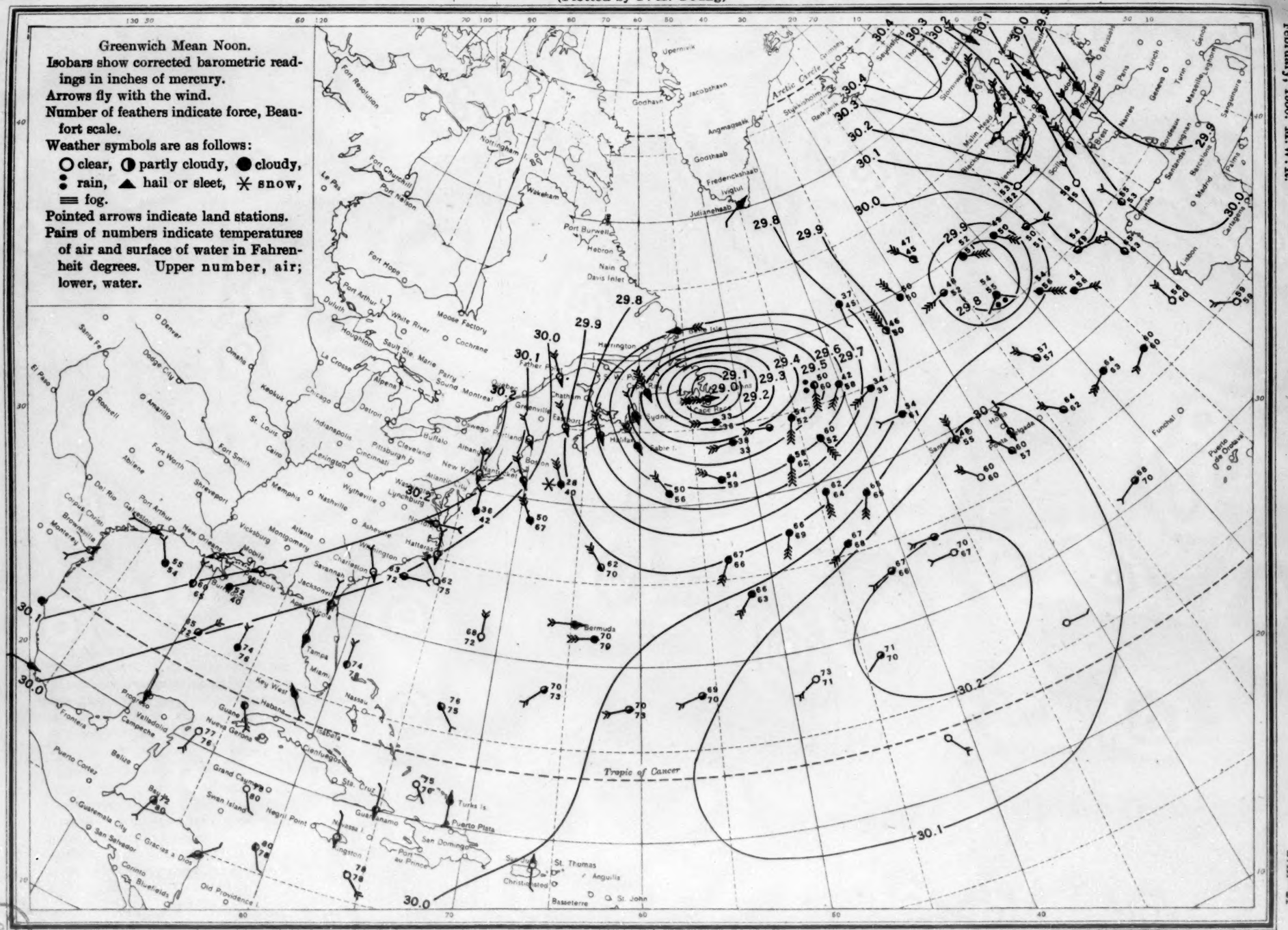
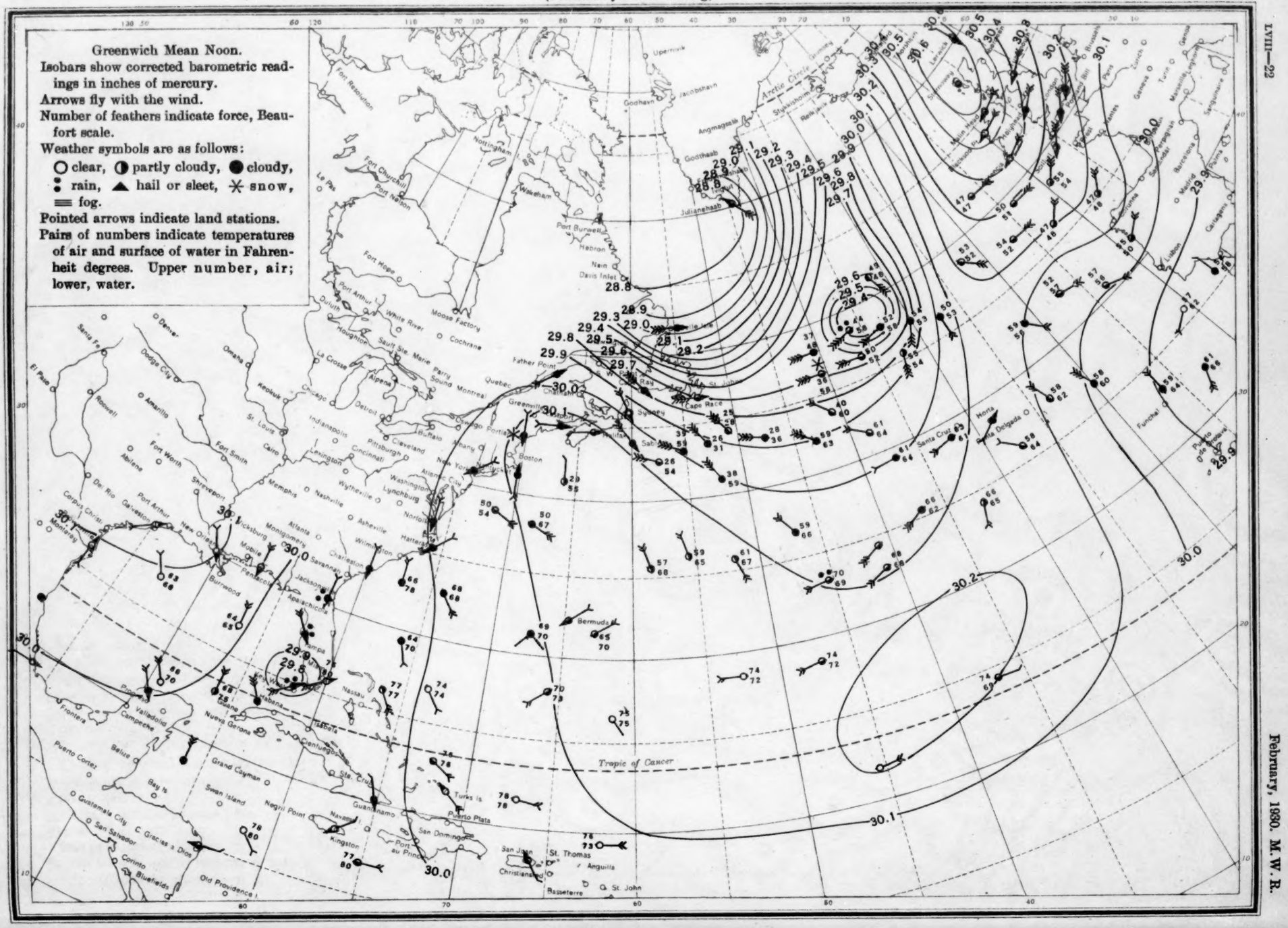


Chart XI. Weather Map of North Atlantic Ocean, February 7, 1930

(Plotted by F. A. Young)